FIG. 1

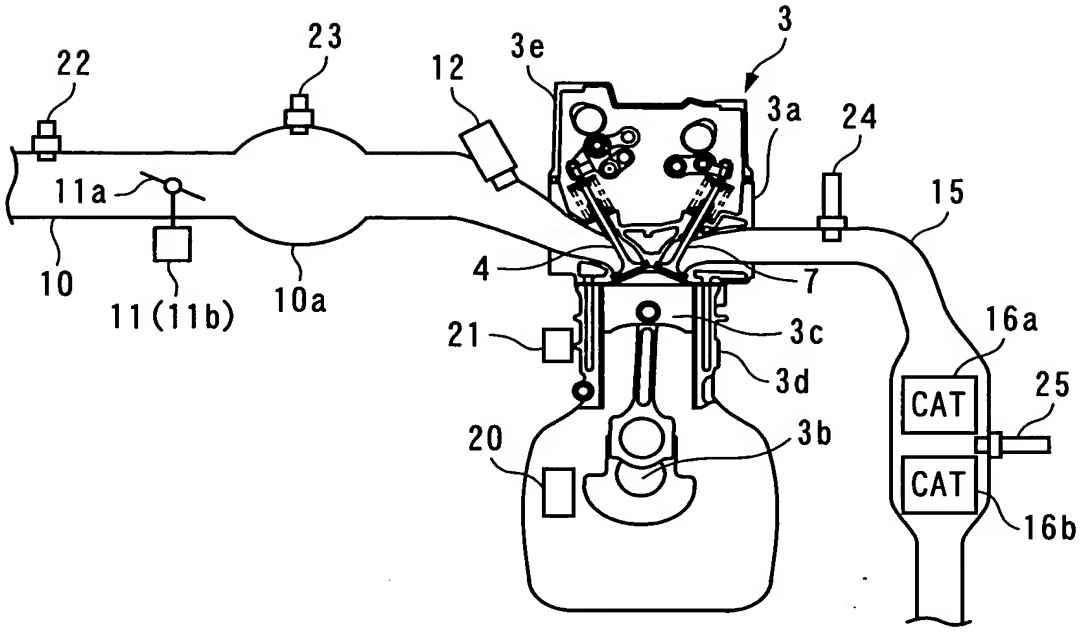

22
23
12
3e
3
3a
24
15
11a
10
11(11b)
10a
4
7
21
3c
3d
16a
25
CAT
20
3b
CAT
16b

FIG. 2

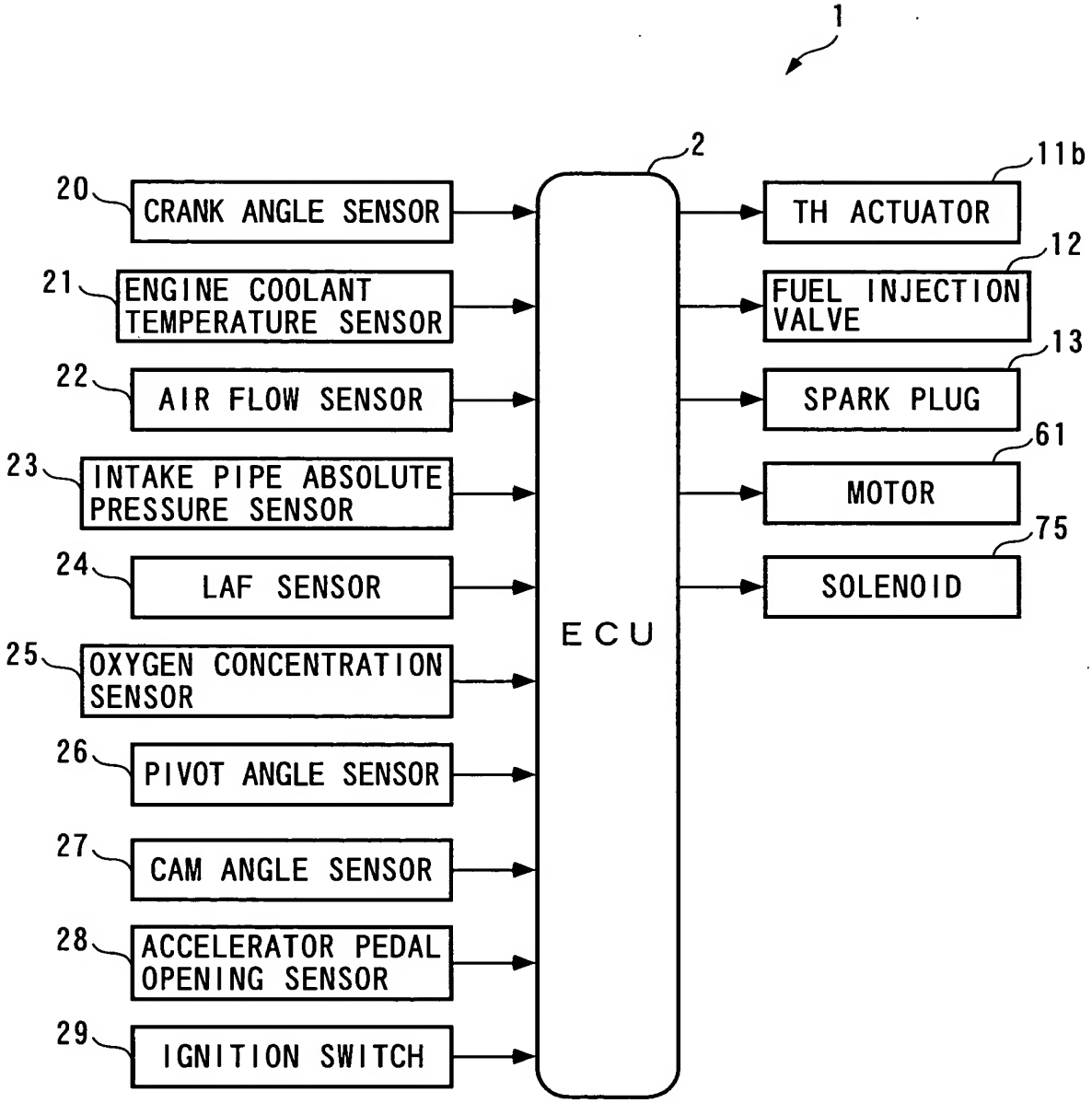

1
2
ECU
20
CRANK ANGLE SENSOR
21
ENGINE COOLANT TEMPERATURE SENSOR
22
AIR FLOW SENSOR
23
INTAKE PIPE ABSOLUTE PRESSURE SENSOR
24
LAF SENSOR
25
OXYGEN CONCENTRATION SENSOR
26
PIVOT ANGLE SENSOR
27
CAM ANGLE SENSOR
28
ACCELERATOR PEDAL OPENING SENSOR
29
IGNITION SWITCH
11b
TH ACTUATOR
12
FUEL INJECTION VALVE
13
SPARK PLUG
61
MOTOR
75
SOLENOID

FIG. 3

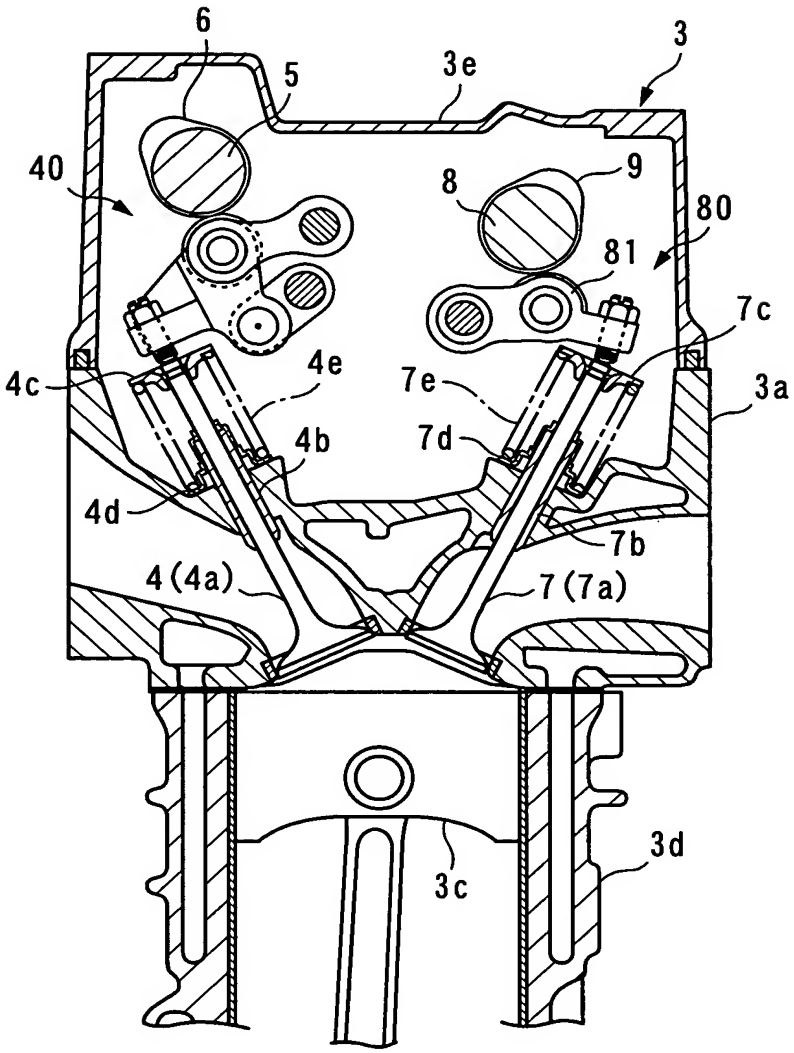


FIG. 4

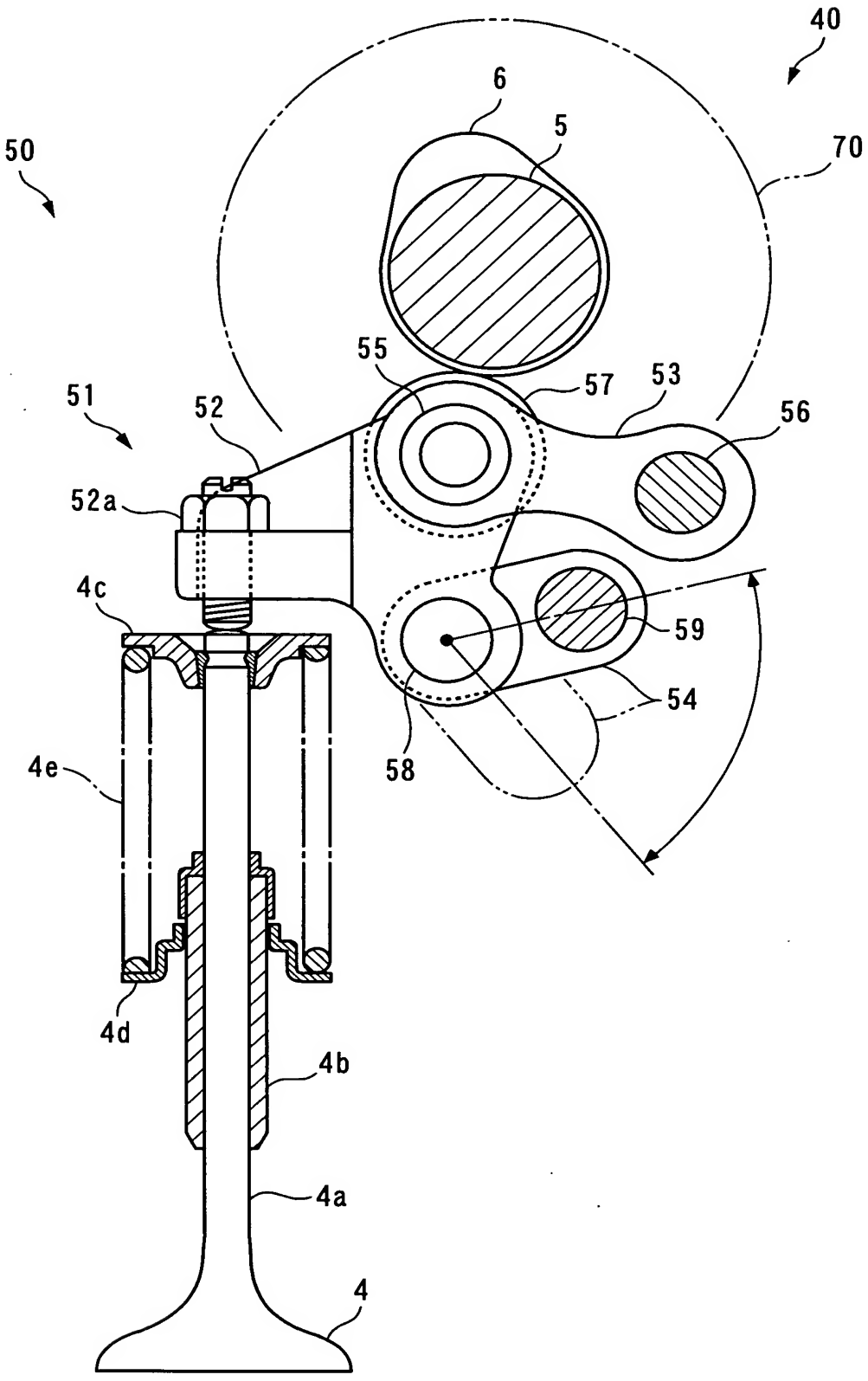
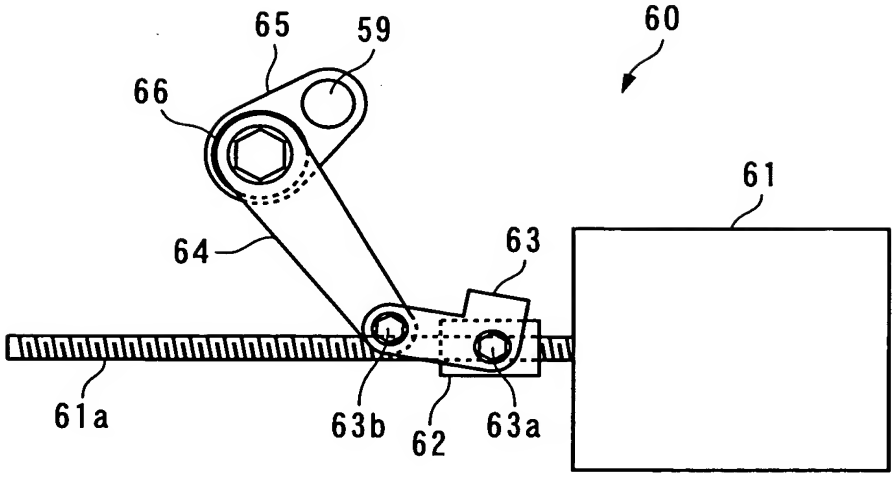


FIG. 5

(a)


65
59
60
66
61
64
63
61a
63b
62
63a

(b)

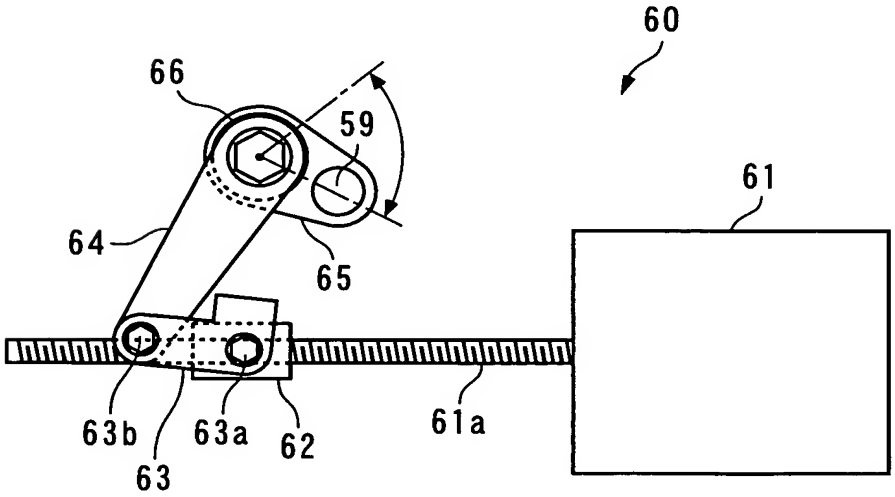

60
66
59
61
64
65
63b
63a
62
61a
63

FIG. 6

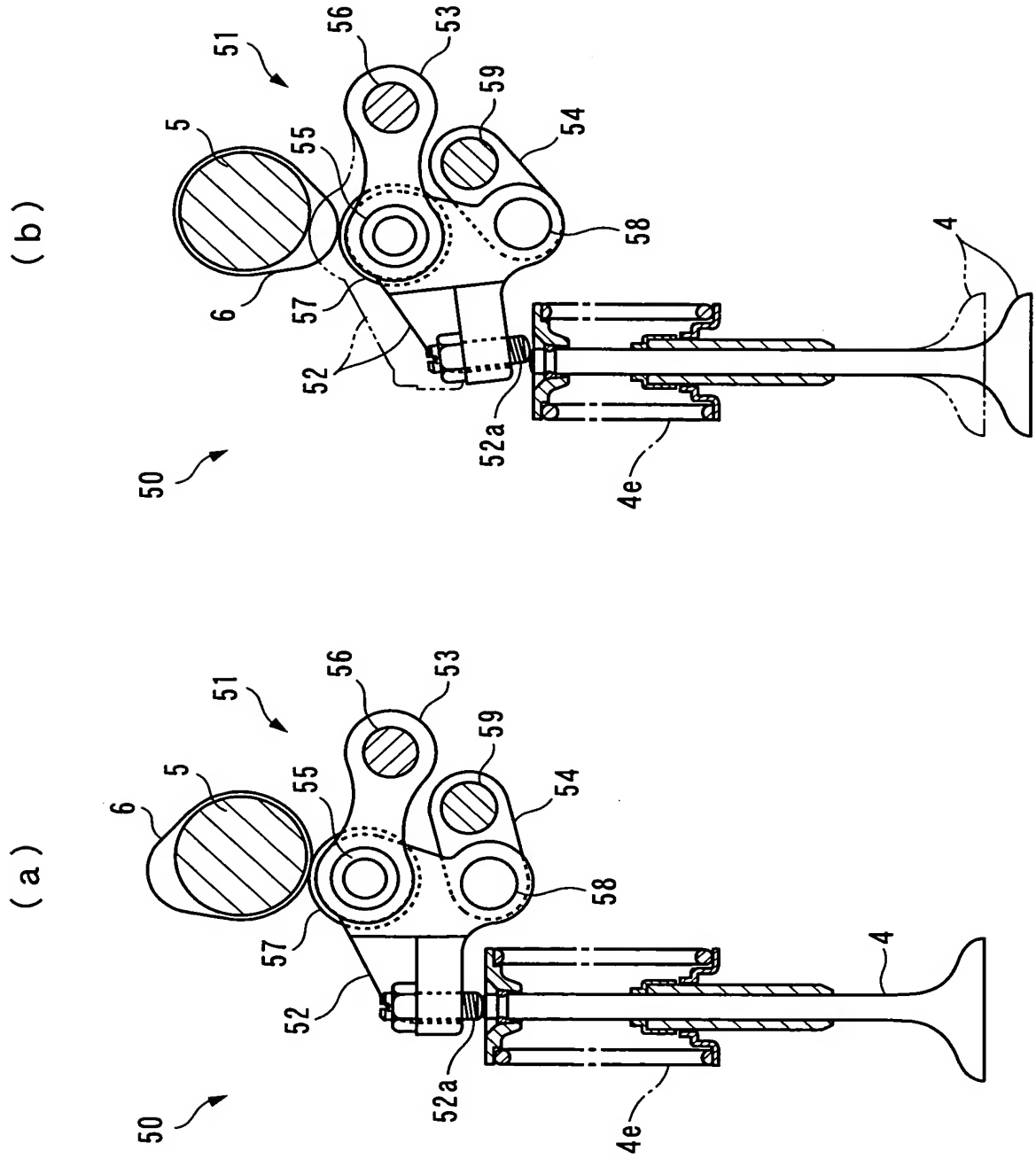


FIG. 7

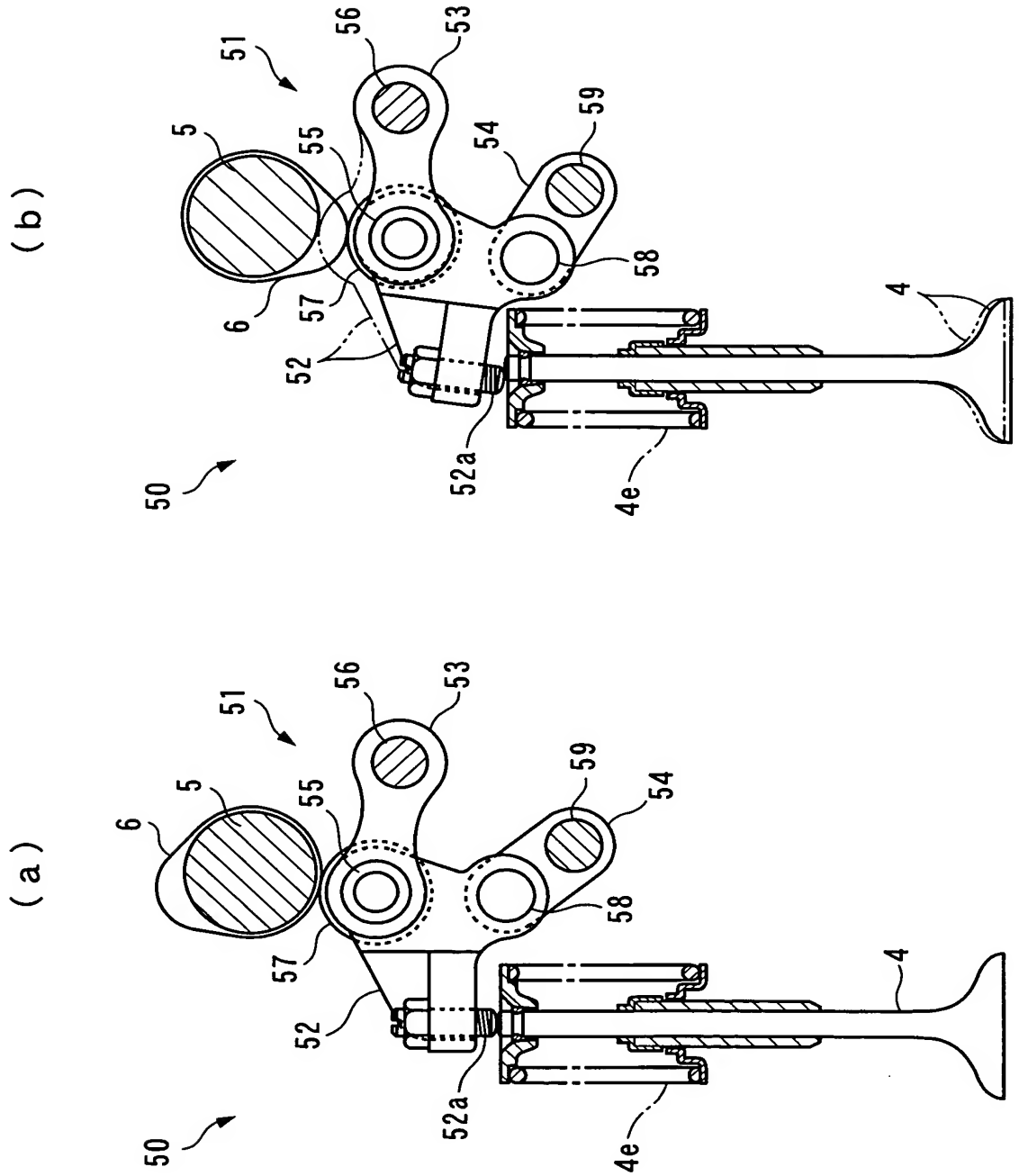
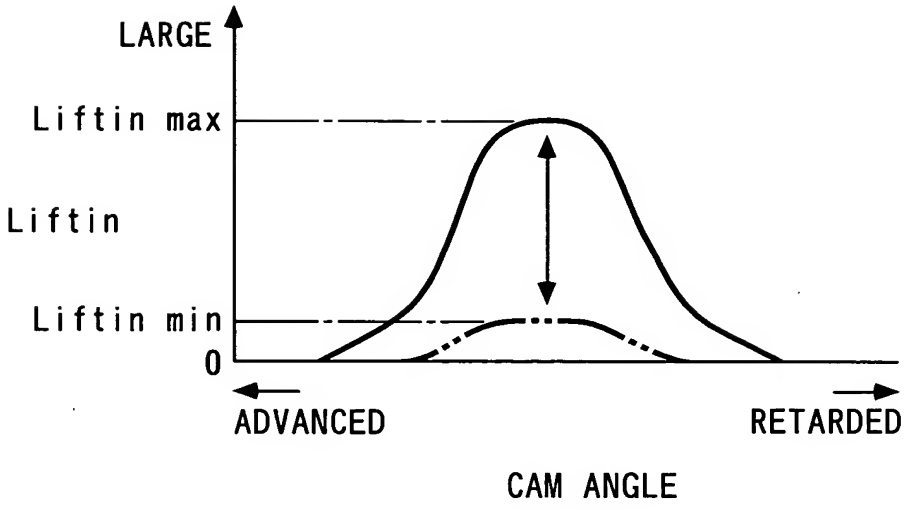


FIG. 8


LARGE
Liftin max
Liftin
Liftin min
0
ADVANCED
RETARDED
CAM ANGLE

Title: Intake Air Amount Control System for Internal Combustion Engine
Inventor: YASUI, et al.
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FIG. 9

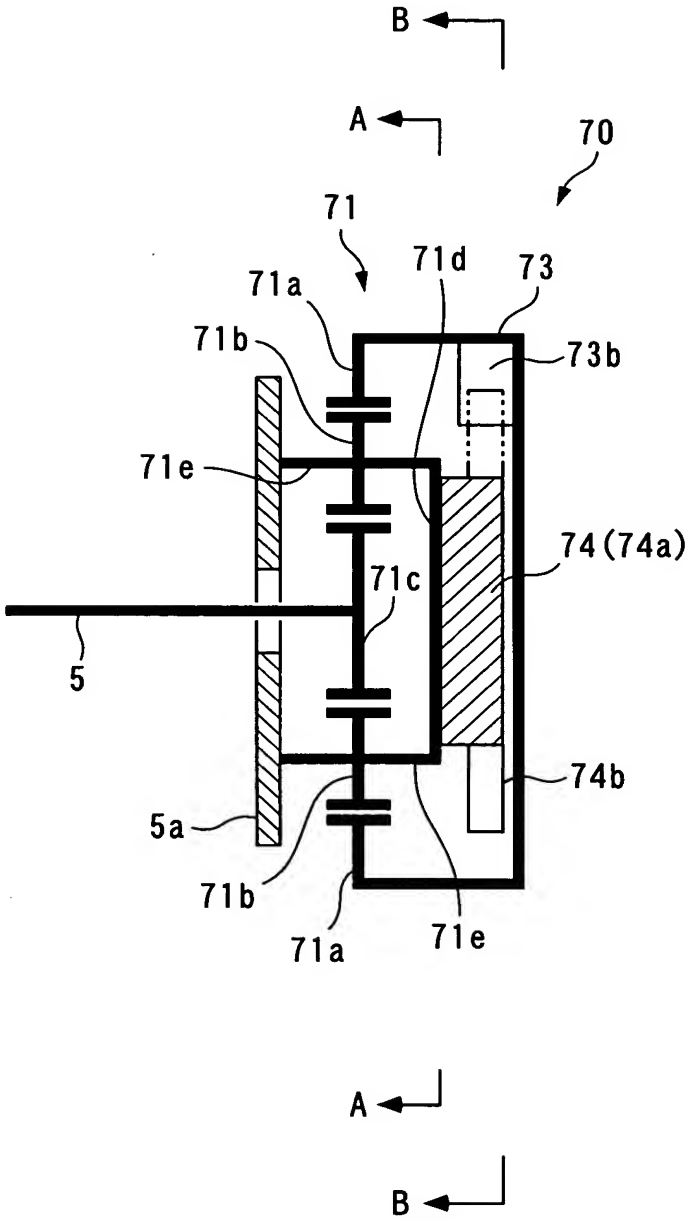


FIG. 10

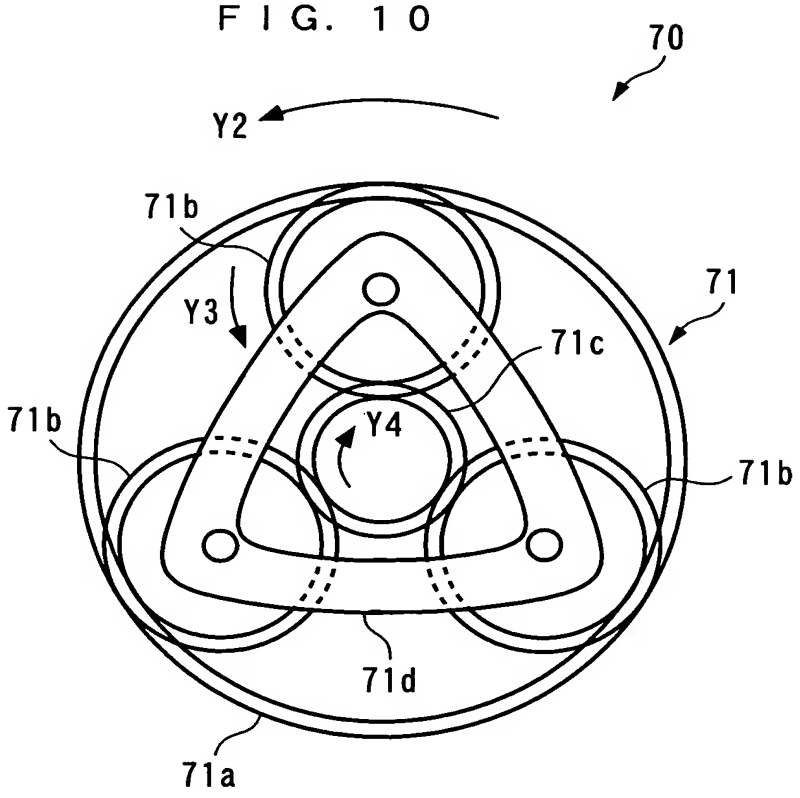

70
Y2
71b
Y3
71
71c
71b
Y4
71b
71d
71a

FIG. 11

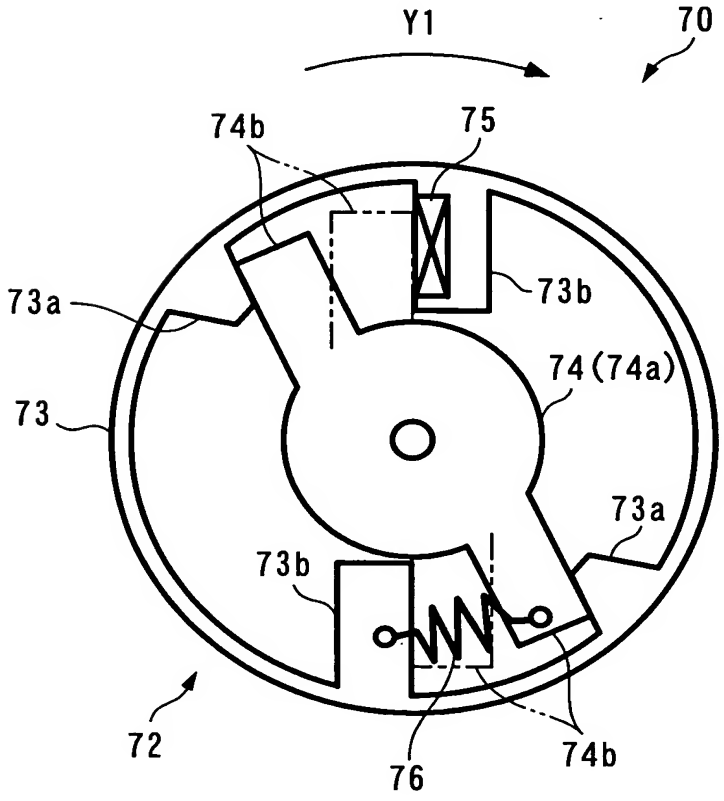

Y1
70
74b
75
73a
73b
74(74a)
73
73a
73b
72
76
74b

FIG. 12

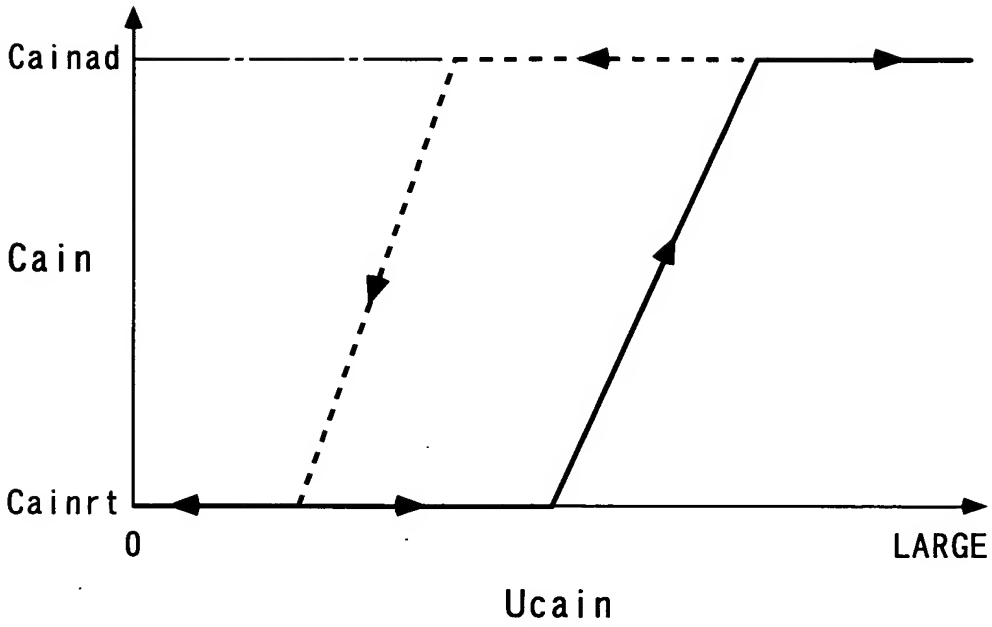


FIG. 13

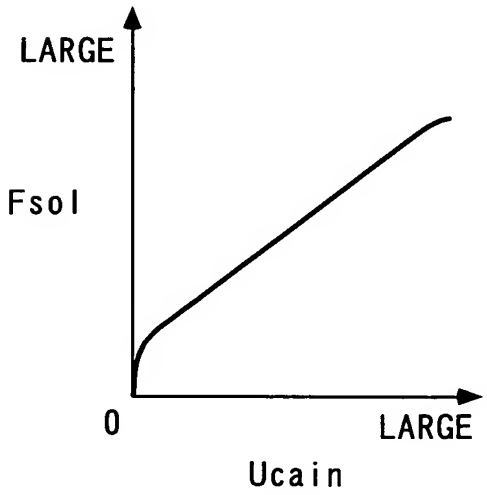


FIG. 14

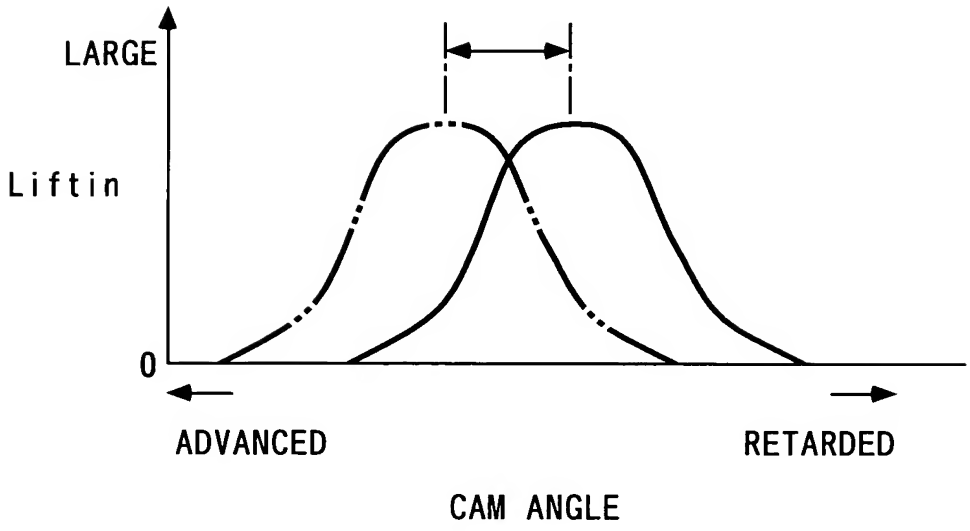


FIG. 15

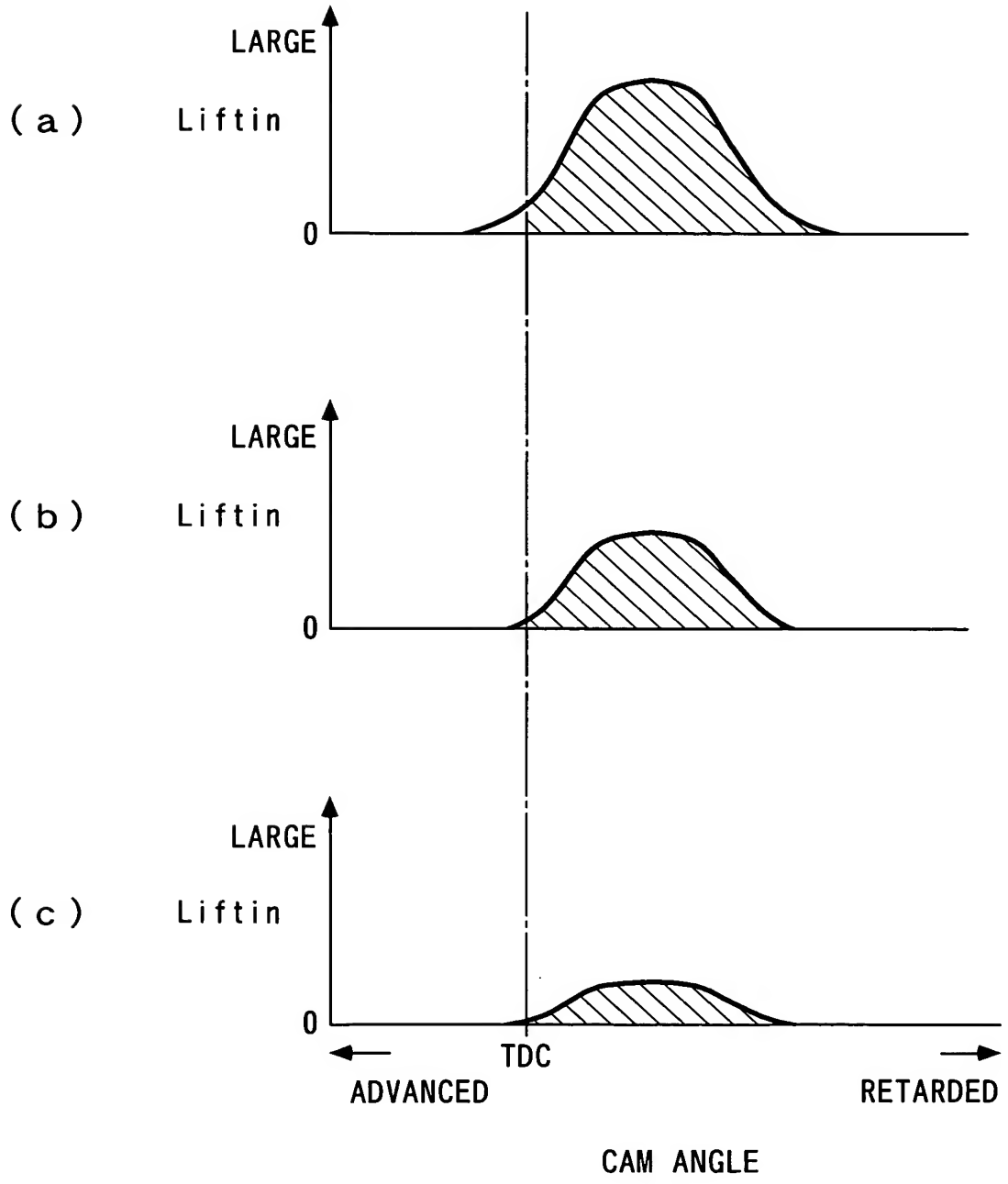
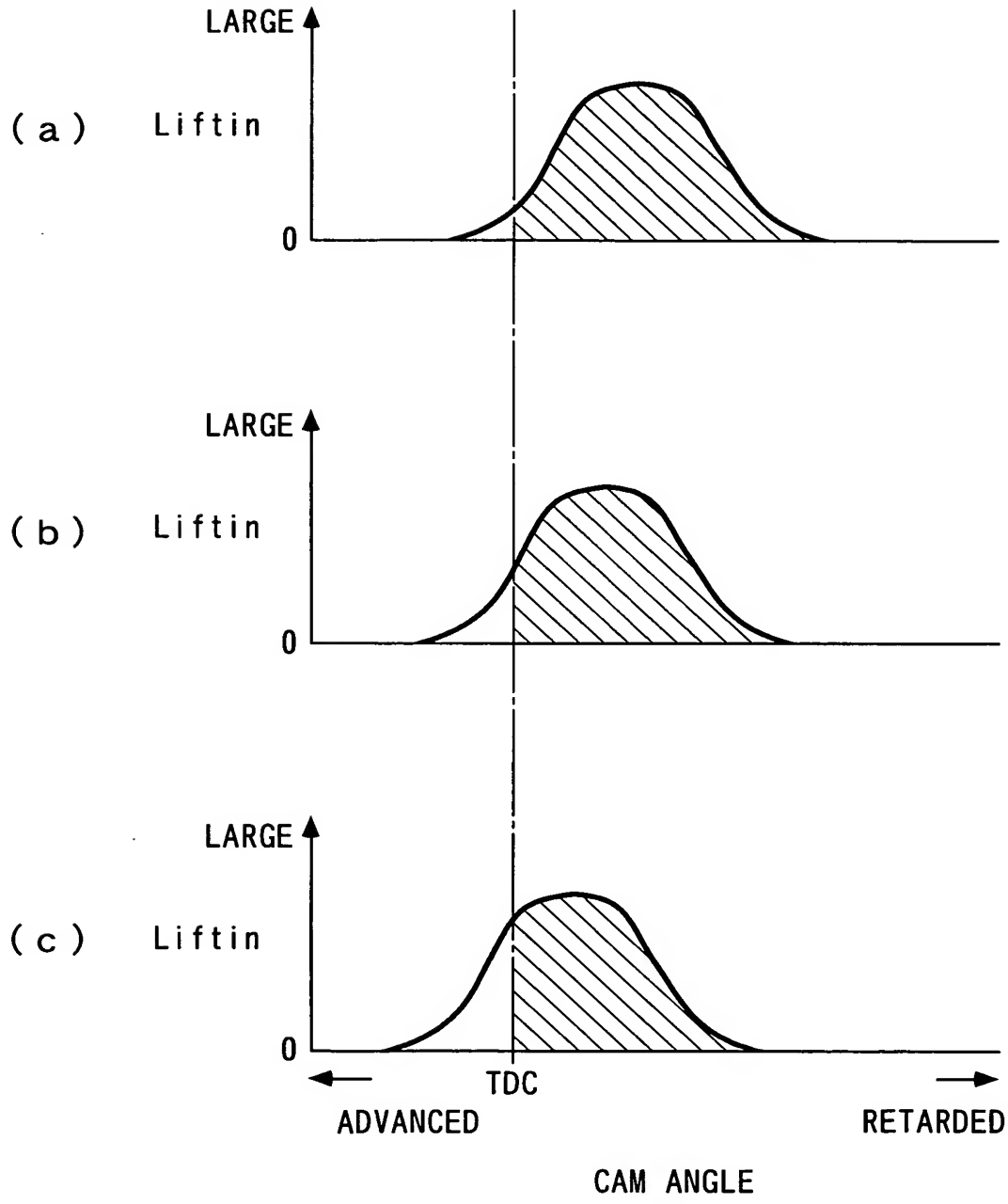
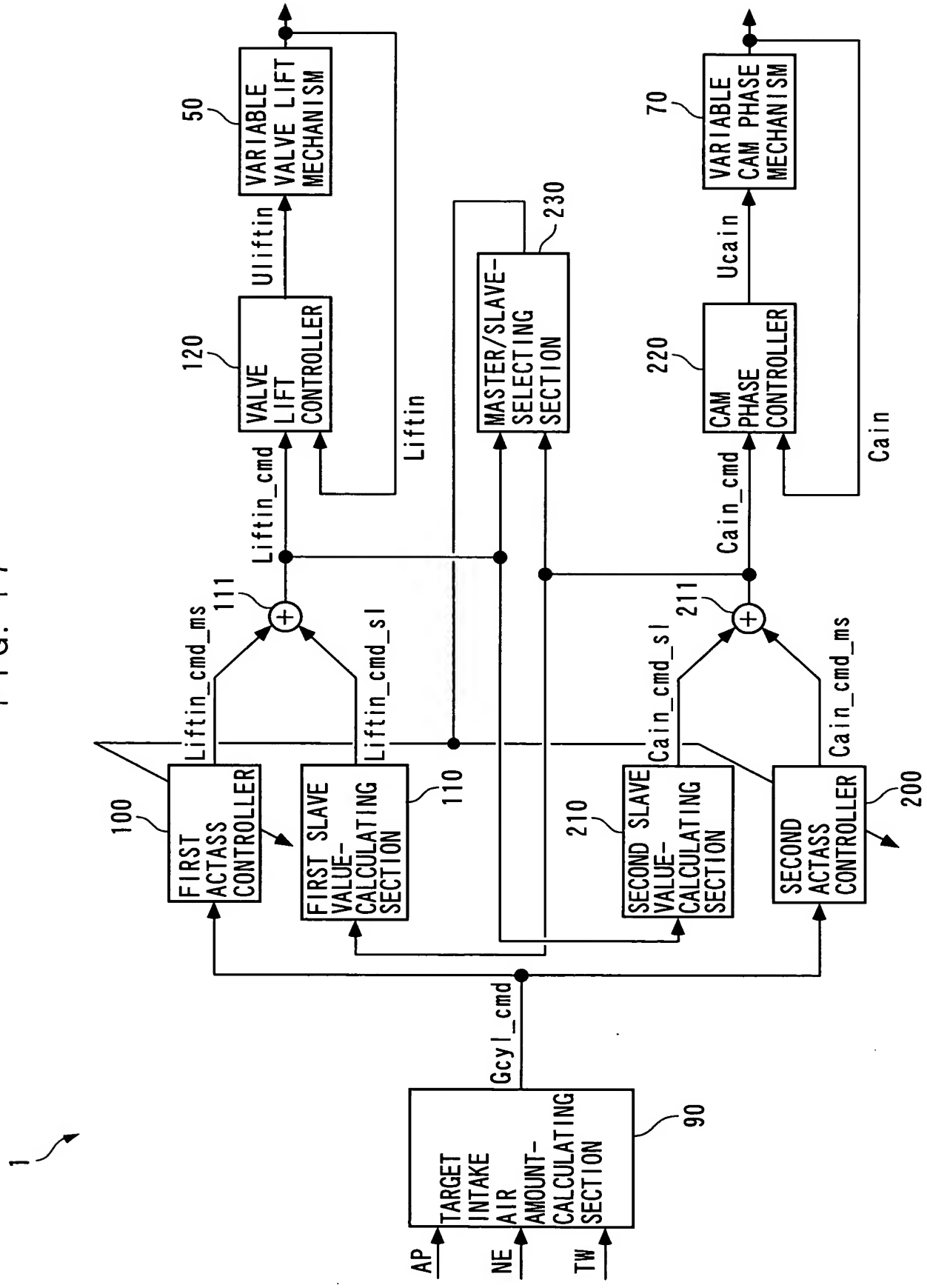

(a)
LARGE
Liftin
0
(b)
LARGE
Liftin
0
(c)
LARGE
Liftin
0
TDC
ADVANCED
RETARDED
CAM ANGLE

FIG. 16


LARGE
(a) Liftin
0
LARGE
(b) Liftin
0
LARGE
(c) Liftin
0
TDC
ADVANCED
RETARDED
CAM ANGLE

Title: Intake Air Amount Control System for Internal Combustion Engine
Inventor: YASUI, et al.
Appln. No. : New Application
Docket No.: 108419-00082

FIG. 17



Title: Intake Air Amount Control System for Internal Combustion Engine
Inventor: YASUI, et al.
Appln. No. : New Application
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FIG. 18

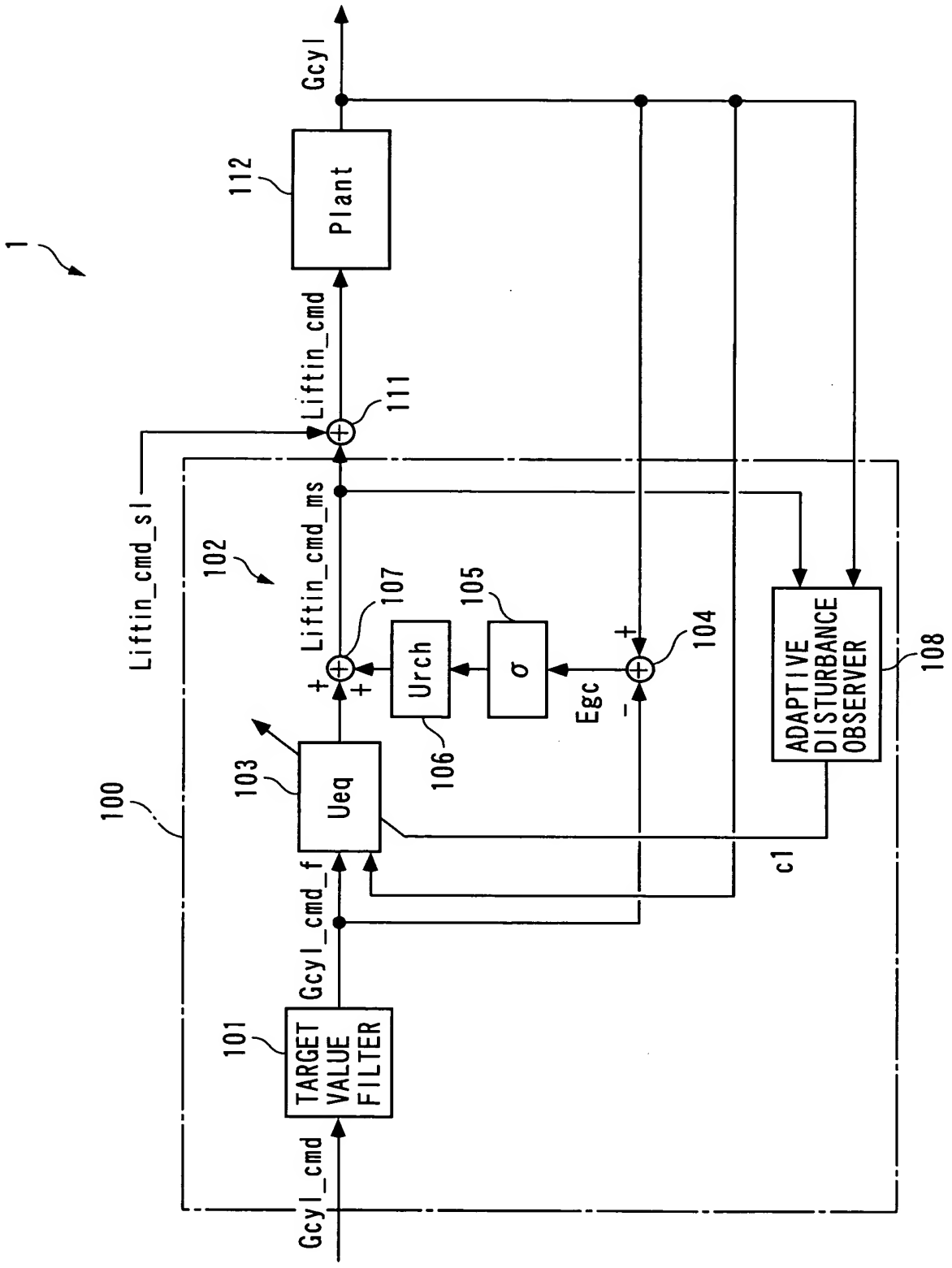


FIG. 19

$$Gcyl(k)=Gth(k)-\frac{VB\cdot[PBA(k)-PBA(k-1)]}{R\cdot TB} \quad \cdots\cdots (1)$$

$$Gcyl\_cmd\_f(k)=-POLE\_f\cdot Gcyl\_cmd\_f(k-1)+(1+POLE\_f)\cdot Gcyl\_cmd(k) \quad \cdots\cdots (2)$$

$$Liftin\_cmd\_ms(k)=Ueq(k)+Urch(k) \quad \cdots\cdots (3)$$

$$Ueq(k)=\frac{1}{b1}\{(1-a1-POLE)\cdot Gcyl(k)+(POLE-a2)\cdot Gcyl(k-1) -b2\cdot Liftin\_cmd\_ms(k-1)-c1(k)+Gcyl\_cmd\_f(k+1) +(POLE-1)\cdot Gcyl\_cmd\_f(k)-POLE\cdot Gcyl\_cmd\_f(k-1)\} \quad \cdots\cdots (4)$$

$$Urch(k)=-\frac{Krch}{b1}\cdot\sigma(k) \quad \cdots\cdots (5)$$

$$\sigma(k)=Egc(k)+POLE\cdot Egc(k-1) \quad \cdots\cdots (6)$$

$$Egc(k)=Gcyl(k)-Gcyl\_cmd\_f(k) \quad \cdots\cdots (7)$$

$$Gcyl(k+1)=a1\cdot Gcyl(k)+a2\cdot Gcyl(k-1) +b1\cdot Liftin\_cmd(k)+b2\cdot Liftin\_cmd(k-1) \quad \cdots\cdots (8)$$

$$Gcyl(k+1)=a1\cdot Gcyl(k)+a2\cdot Gcyl(k-1) +b1\cdot Liftin\_cmd\_ms(k)+b2\cdot Liftin\_cmd\_ms(k-1) \quad \cdots\cdots (9)$$

FIG. 20

$$c1(k)=c1(k-1)+\frac{Pdov}{1+Pdov}\cdot e\_dov(k) \quad \cdots\cdots (10)$$

$$e\_dov(k)=Gcyl(k)-Gcyl\_hat(k) \quad \cdots\cdots (11)$$

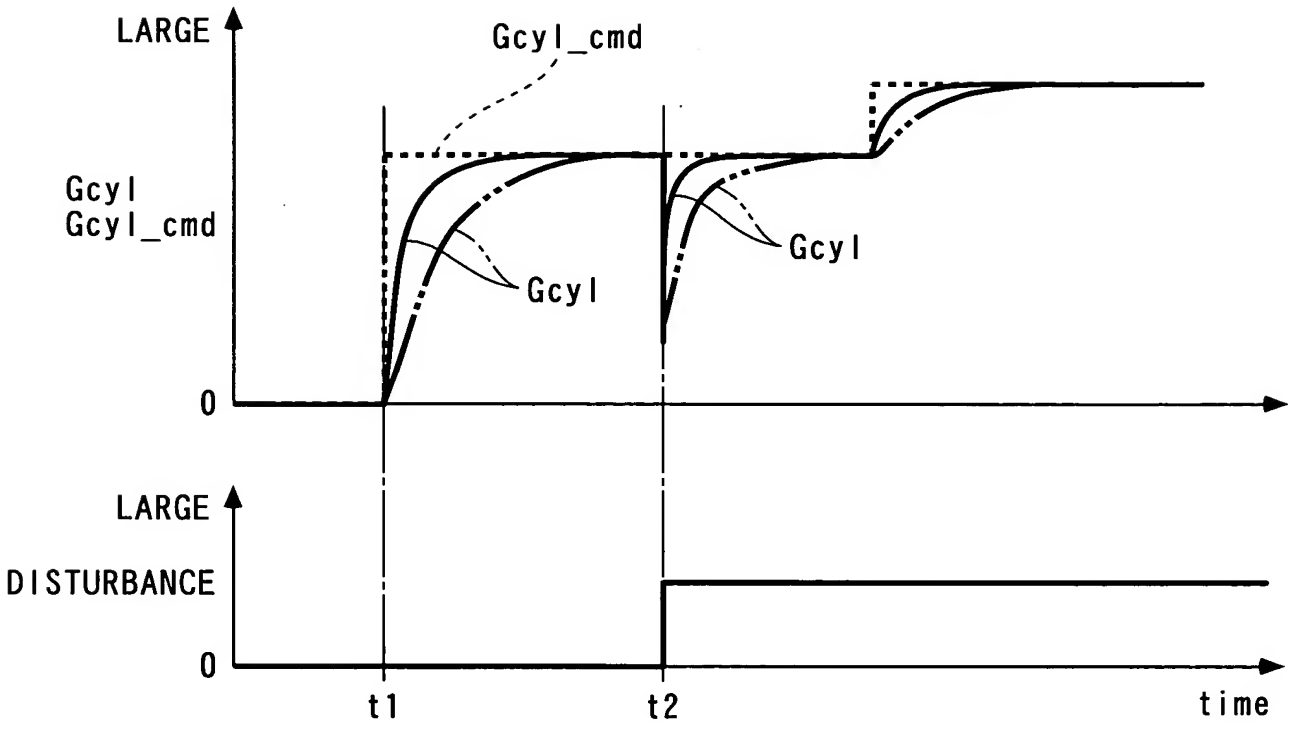
$$Gcyl\_hat(k)=\theta(k-1)^T\cdot\zeta(k) \quad \cdots\cdots (12)$$

$$\theta(k)^T=[a1,a2,b1,b2,c1(k)] \quad \cdots\cdots (13)$$

$$\zeta(k)^T=[Gcyl(k-1),Gcyl(k-2),Liftin\_cmd\_ms(k-1),Liftin\_cmd\_ms(k-2),1] \quad \cdots\cdots (14)$$

$$\begin{aligned}c1(k)=&-Krch\cdot\sigma(k)+(1-a1-POLE)\cdot Gcyl(k)+(POLE-a2)\cdot Gcyl(k-1)\\&-b2\cdot Liftin\_cmd\_ms(k-1)+Gcyl\_cmd\_f(k+1)\\&+(POLE-1)\cdot Gcyl\_cmd\_f(k)-POLE\cdot Gcyl\_cmd\_f(k-1)\end{aligned} \quad \cdots\cdots (15)$$

FIG. 21


LARGE
Gcyl_cmd
Gcyl
Gcyl_cmd
Gcyl
Gcyl
0
LARGE
DISTURBANCE
0
t1
t2
time

Title: Intake Air Amount Control System for Internal Combustion Engine
Inventor: YASUI, et al.
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FIG. 22

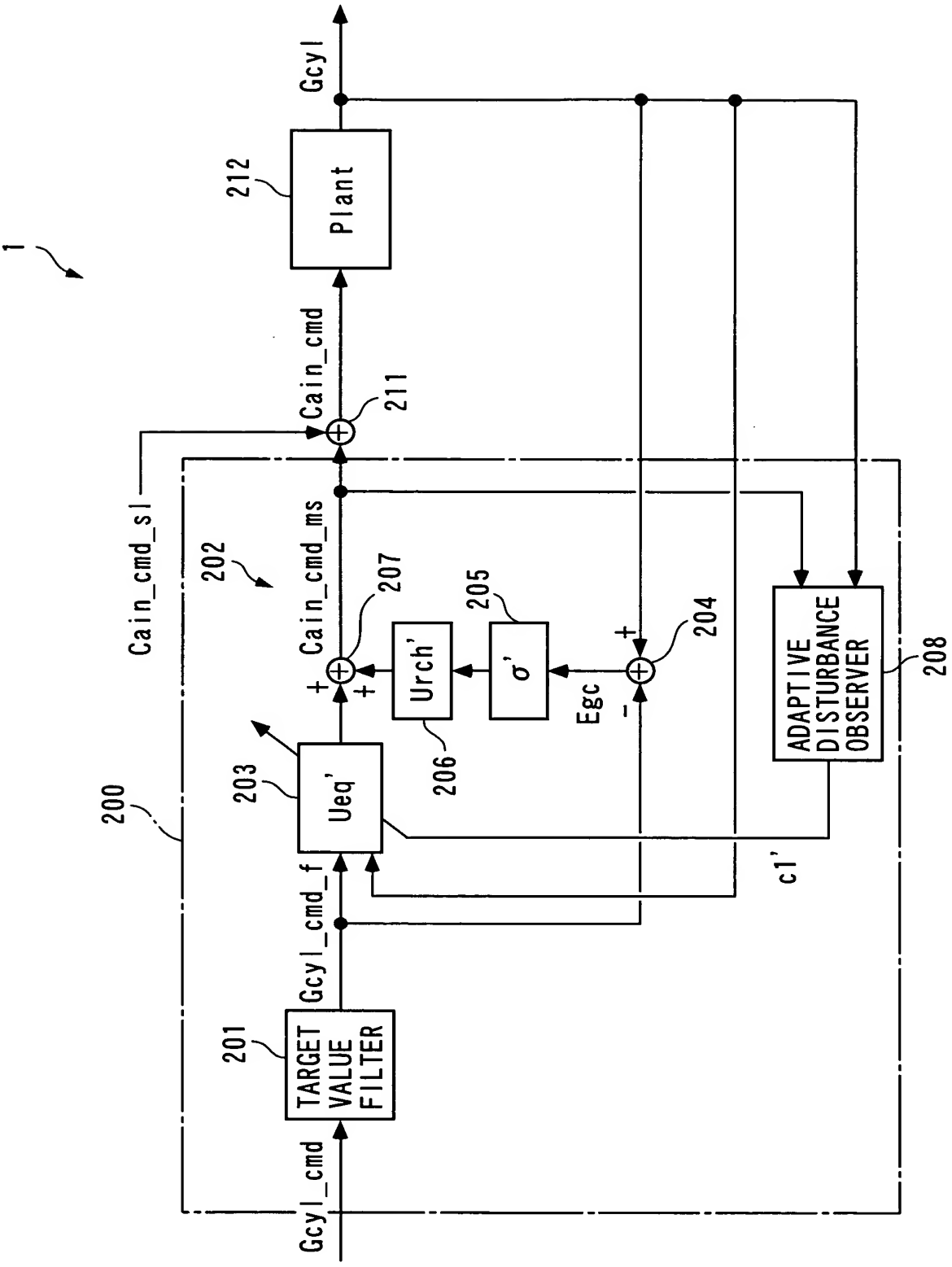


FIG. 23

$$Gcyl\_cmd\_f(k) = -POLE\_f \cdot Gcyl\_cmd\_f(k-1) + (1+POLE\_f) \cdot Gcyl\_cmd(k) \quad \cdots\cdots (16)$$

$$Cain\_cmd\_ms(k) = Ueq'(k) + Urch'(k) \quad \cdots\cdots (17)$$

$$Ueq'(k) = \frac{1}{b1'}\{(1-a1'-POLE') \cdot Gcyl(k) + (POLE'-a2') \cdot Gcyl(k-1) - b2' \cdot Cain\_cmd\_ms(k-1) - c1'(k) + Gcyl\_cmd\_f(k+1) + (POLE'-1) \cdot Gcyl\_cmd\_f(k) - POLE' \cdot Gcyl\_cmd\_f(k-1)\} \quad \cdots\cdots (18)$$

$$Urch'(k) = -\frac{Krch'}{b1'} \cdot \sigma'(k) \quad \cdots\cdots (19)$$

$$\sigma'(k) = Egc(k) + POLE' \cdot Egc(k-1) \quad \cdots\cdots (20)$$

$$Egc(k) = Gcyl(k) - Gcyl\_cmd\_f(k) \quad \cdots\cdots (21)$$

$$Gcyl(k+1) = a1' \cdot Gcyl(k) + a2' \cdot Gcyl(k-1) + b1' \cdot Cain\_cmd(k) + b2' \cdot Cain\_cmd(k-1) \quad \cdots\cdots (22)$$

$$Gcyl(k+1) = a1' \cdot Gcyl(k) + a2' \cdot Gcyl(k-1) + b1' \cdot Cain\_cmd\_ms(k) + b2' \cdot Cain\_cmd\_ms(k-1) \quad \cdots\cdots (23)$$

FIG. 24

$$c1'(k) = c1'(k-1) + \frac{Pdov'}{1+Pdov'} \cdot e\_dov'(k) \quad \cdots\cdots (24)$$

$$e\_dov'(k) = Gcyl(k) - Gcyl\_hat'(k) \quad \cdots\cdots (25)$$

$$Gcyl\_hat'(k) = \theta'(k-1)^T \cdot \zeta'(k) \quad \cdots\cdots (26)$$

$$\theta'(k)^T = [a1', a2', b1', b2', c1'(k)] \quad \cdots\cdots (27)$$

$$\zeta'(k)^T = [Gcyl(k-1), Gcyl(k-2), Cain\_cmd\_ms(k-1), Cain\_cmd\_ms(k-2), 1] \quad \cdots\cdots (28)$$

$$\begin{aligned} c1'(k) = &-Krch' \cdot \sigma'(k) + (1-a1'-POLE') \cdot Gcyl(k) + (POLE'-a2') \cdot Gcyl(k-1) \\ &-b2' \cdot Cain\_cmd\_ms(k-1) + Gcyl\_cmd\_f(k+1) \\ &+ (POLE'-1) \cdot Gcyl\_cmd\_f(k) - POLE' \cdot Gcyl\_cmd\_f(k-1) \end{aligned} \quad \cdots\cdots (29)$$

FIG. 25

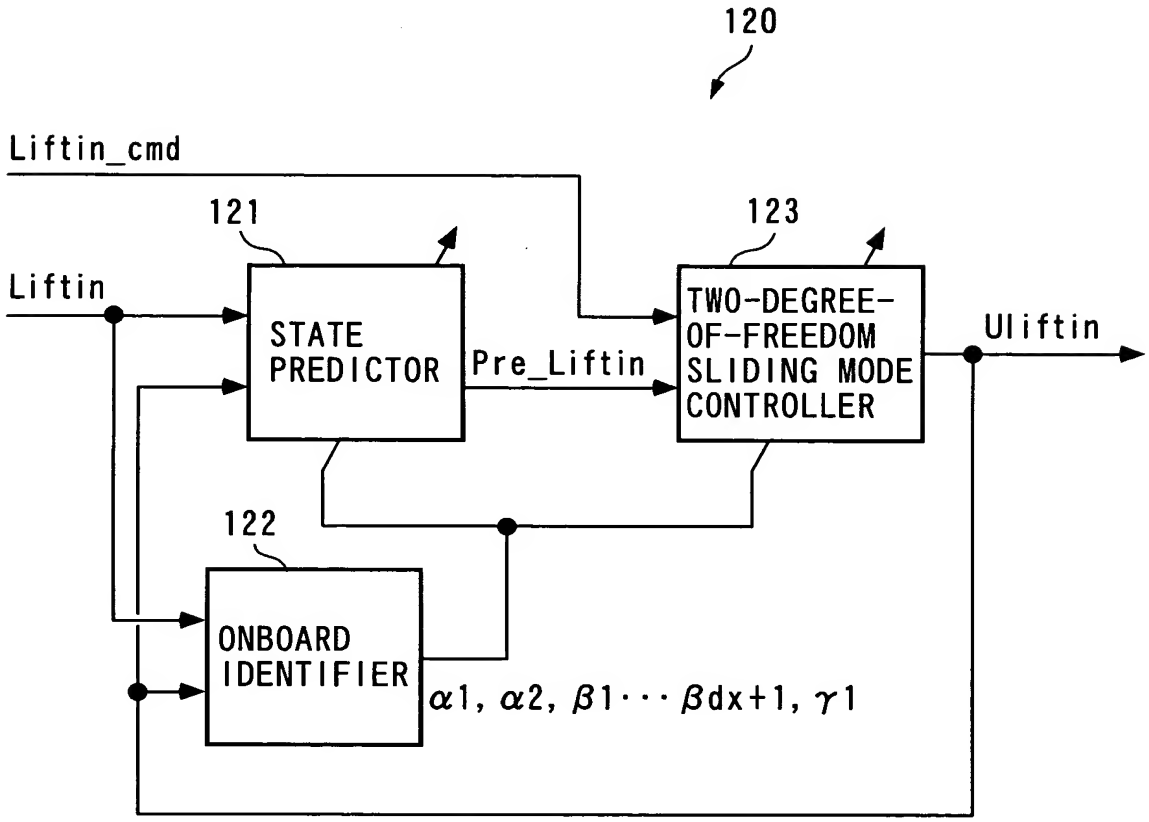

120
Liftin_cmd
121
123
Liftin
STATE PREDICTOR
Pre_Liftin
TWO-DEGREE-OF-FREEDOM SLIDING MODE CONTROLLER
Uliftin
122
ONBOARD IDENTIFIER
α1, α2, β1・・・βdx+1, γ1

FIG. 26

$$Liftin(n+1)=a1''\cdot Liftin(n)+a2''\cdot Liftin(n-1)+b1''\cdot Uliftin(n-dx)+b2''\cdot Uliftin(n-dx-1) \quad \cdots\cdots (30)$$

$$\boldsymbol{A}=\begin{bmatrix} a1'' & a2'' \\ 1 & 0 \end{bmatrix} \quad \cdots\cdots (31)$$

$$\boldsymbol{B}=\begin{bmatrix} b1'' & b2'' \\ 0 & 0 \end{bmatrix} \quad \cdots\cdots (32)$$

$$Liftin(n+dx)=\alpha1(n)\cdot Liftin(n)+\alpha2(n)\cdot Liftin(n-1)+\beta1(n)\cdot Uliftin(n-1)+\beta2(n)\cdot Uliftin(n-2)+\cdots\cdots+\beta dx(n)\cdot Uliftin(n-dx)+\beta dx+1(n)\cdot Uliftin(n-dx-1) \quad \cdots\cdots (33)$$

$\alpha1$: 1ST ROW-1ST COLUMN COMPONENT OF $\boldsymbol{A}^{dx}$

$\alpha2$: 1ST ROW-2ND COLUMN COMPONENT OF $\boldsymbol{A}^{dx}$

βj ($j=1\sim dx+1$) :
- 1ST ROW-1ST COLUMN COMPONENT ($j=1$) OF $\boldsymbol{A}^{j-1}\boldsymbol{B}$
- 1ST ROW-1ST COLUMN COMPONENT OF $\boldsymbol{A}^{j-1}\boldsymbol{B}$
- +1ST ROW-2ND COLUMN COMPONENT ($j=2\sim dx$) OF $\boldsymbol{A}^{j-2}\boldsymbol{B}$
- 1ST ROW-2ND COLUMN COMPONENT ($j=dx+1$) OF $\boldsymbol{A}^{j-2}\boldsymbol{B}$

$$Pre\_Liftin(n)=\alpha1(n)\cdot Liftin(n)+\alpha2(n)\cdot Liftin(n-1)+\beta1(n)\cdot Uliftin(n-1)+\beta2(n)\cdot Uliftin(n-2)+\cdots\cdots+\beta dx(n)\cdot Uliftin(n-dx)+\beta dx+1(n)\cdot Uliftin(n-dx-1)+\gamma1(n) \quad \cdots\cdots (34)$$

FIG. 27

$$\theta x(n) = \theta x(n-1) + KP(n) \cdot ide(n) \quad \cdots\cdots (35)$$

$$KP(n) = \frac{P(n) \cdot \zeta x(n)}{1 + \zeta x(n)^T \cdot P(n) \cdot \zeta x(n)} \quad \cdots\cdots (36)$$

$$P(n+1) = \frac{1}{\lambda 1}\left[I - \frac{\lambda 2 \cdot P(n) \cdot \zeta x(n) \cdot \zeta x(n)^T}{\lambda 1 + \lambda 2 \cdot \zeta x(n)^T \cdot P(n) \cdot \zeta x(n)}\right] \cdot P(n) \quad \cdots\cdots (37)$$

I : UNIT MATRIX OF ORDER dx+2
$\lambda 1, \lambda 2$: WEIGHTING PARAMETER

$$ide(n) = Liftin\_hat(n) - Liftin(n)$$
$$= \theta x(n-1)^T \cdot \zeta x(n) - Liftin(n) \quad \cdots\cdots (38)$$

$$\theta x(n)^T = [\alpha 1(n), \alpha 2(n), \beta 1(n), \beta 2(n), \cdots, \beta dx+1(n), \gamma 1(n)] \quad \cdots\cdots (39)$$

$$\zeta x(n)^T = [Liftin(n-dx), Liftin(n-dx-1), Uliftin(n-dx-1), Uliftin(n-dx-2), \cdots\cdots, Uliftin(n-2dx-1), 1] \quad \cdots\cdots (40)$$

FIG. 28

$$Liftin\_cmd\_f(n) = -POLE\_f'' \cdot Liftin\_cmd\_f(n-1) + (1+POLE\_f'') \cdot Liftin\_cmd(n) \quad \cdots\cdots (41)$$

$$Uliftin(n) = Ueq''(n) + Urch''(n) \quad \cdots\cdots (42)$$

$$\begin{aligned} Ueq''(n) = \frac{1}{\beta 1(n)} \{ & -POLE'' \cdot Pre\_Liftin(n) + Pre\_Liftin(n-1) \\ & + POLE'' \cdot Pre\_Liftin(n-2) - \alpha 1(n) \cdot Pre\_Liftin(n-dx+1) \\ & - \alpha 2(n) \cdot Pre\_Liftin(n-dx) - \beta 2(n) \cdot Uliftin(n-1) \\ & - \cdots - \beta dx(n) \cdot Uliftin(n-dx+1) \\ & - \beta dx+1(n) \cdot Uliftin(n-dx) - \gamma 1(n) \\ & + Liftin\_cmd\_f(n) + POLE'' \cdot Liftin\_cmd\_f(n-1) \\ & - Liftin\_cmd\_f(n-1) - POLE'' \cdot Liftin\_cmd\_f(n-2) \} \end{aligned} \quad \cdots\cdots (43)$$

$$Urch''(n) = -\frac{Krch''}{\beta 1(n)} \cdot Pre\_\sigma''(n) \quad \cdots\cdots (44)$$

$$Pre\_\sigma''(n) = Pre\_E\_lf(n) + POLE'' \cdot Pre\_E\_lf(n-1) \quad \cdots\cdots (45)$$

$$Pre\_E\_lf(n) = Pre\_Liftin(n) - Liftin\_cmd\_f(n) \quad \cdots\cdots (46)$$

FIG. 29

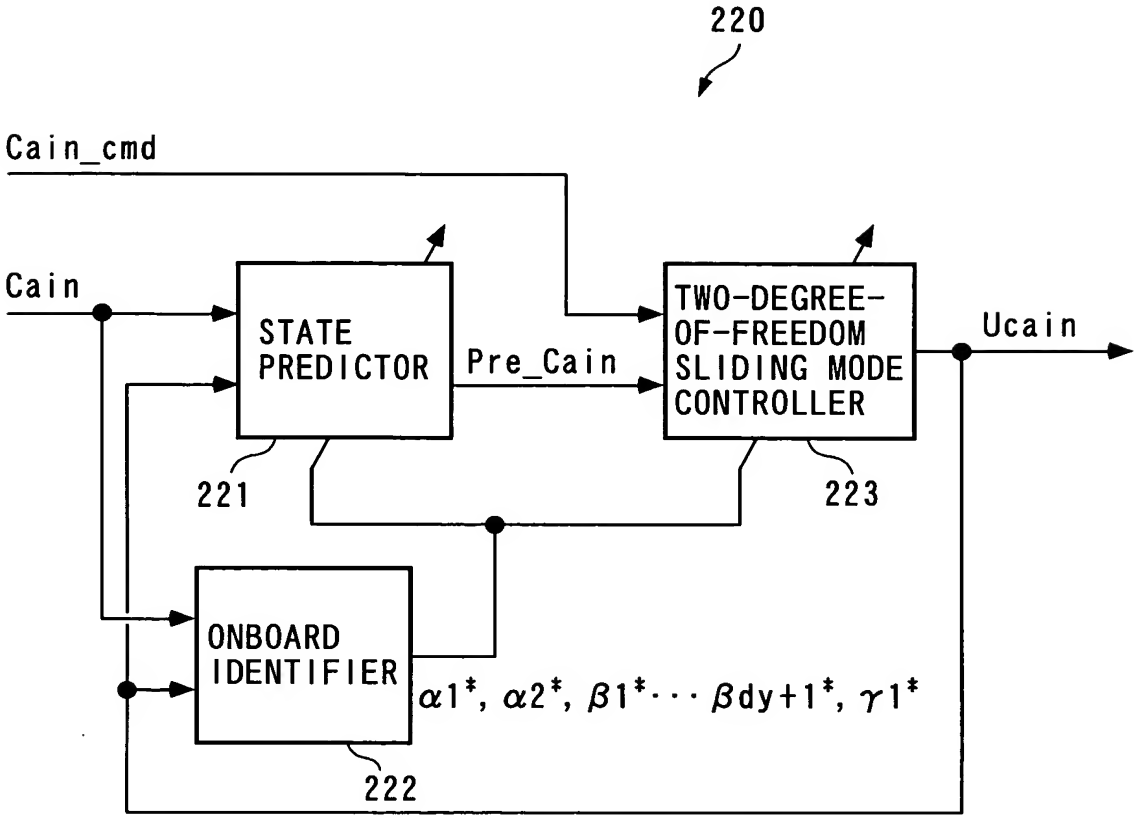

220
Cain_cmd
Cain
STATE PREDICTOR
Pre_Cain
TWO-DEGREE-OF-FREEDOM SLIDING MODE CONTROLLER
Ucain
221
223
ONBOARD IDENTIFIER
α1*, α2*, β1*・・・βdy+1*, γ1*
222

FIG. 30

$$Cain(n+1)=a1^{*}\cdot Cain(n)+a2^{*}\cdot Cain(n-1)+b1^{*}\cdot Ucain(n-dy)+b2^{*}\cdot Ucain(n-dy-1) \quad \cdots\cdots (47)$$

$$\boldsymbol{A}y=\begin{bmatrix} a1^{*} & a2^{*} \\ 1 & 0 \end{bmatrix} \quad \cdots\cdots (48)$$

$$\boldsymbol{B}y=\begin{bmatrix} b1^{*} & b2^{*} \\ 0 & 0 \end{bmatrix} \quad \cdots\cdots (49)$$

$$Cain(n+dy)=\alpha1^{*}(n)\cdot Cain(n)+\alpha2^{*}(n)\cdot Cain(n-1)+\beta1^{*}(n)\cdot Ucain(n-1)+\beta2^{*}(n)\cdot Ucain(n-2)+\cdots\cdots+\beta dy^{*}(n)\cdot Ucain(n-dy)+\beta dy+1^{*}(n)\cdot Ucain(n-dy-1) \quad \cdots\cdots (50)$$

$\alpha1^{*}$: 1ST ROW-1ST COLUMN COMPONENT OF $\boldsymbol{A}y^{dy}$

$\alpha2^{*}$: 1ST ROW-2ND COLUMN COMPONENT OF $\boldsymbol{A}y^{dy}$

βj^{*} ($j=1\sim dy+1$):
- 1ST ROW-1ST COLUMN COMPONENT ($j=1$) OF $\boldsymbol{A}y^{j-1}\boldsymbol{B}y$
- 1ST ROW-1ST COLUMN COMPONENT OF $\boldsymbol{A}y^{j-1}\boldsymbol{B}y$
- +1ST ROW-2ND COLUMN COMPONENT ($j=2\sim dy$) OF $\boldsymbol{A}y^{j-2}\boldsymbol{B}y$
- 1ST ROW-2ND COLUMN COMPONENT ($j=dy+1$) OF $\boldsymbol{A}y^{j-2}\boldsymbol{B}y$

$$Pre\_Cain(n)=\alpha1^{*}(n)\cdot Cain(n)+\alpha2^{*}(n)\cdot Cain(n-1)+\beta1^{*}(n)\cdot Ucain(n-1)+\beta2^{*}(n)\cdot Ucain(n-2)+\cdots\cdots+\beta dy^{*}(n)\cdot Ucain(n-dy)+\beta dy+1^{*}(n)\cdot Ucain(n-dy-1)+\gamma1^{*}(n) \quad \cdots\cdots (51)$$

FIG. 31

$$\theta^*(n)=\theta^*(n-1)+KP^*(n)\cdot ide^*(n) \quad \cdots\cdots (52)$$

$$KP^*(n)=\frac{P^*(n)\cdot\zeta^*(n)}{1+\zeta^*(n)^T\cdot P^*(n)\cdot\zeta^*(n)} \quad \cdots\cdots (53)$$

$$P^*(n+1)=\frac{1}{\lambda 1^*}\left[I-\frac{\lambda 2^*\cdot P^*(n)\cdot\zeta^*(n)\cdot\zeta^*(n)^T}{\lambda 1^*+\lambda 2^*\cdot\zeta^*(n)^T\cdot P^*(n)\cdot\zeta^*(n)}\right]\cdot P^*(n) \quad \cdots\cdots (54)$$

I : UNIT MATRIX OF ORDER dy+2
$\lambda 1^*$, $\lambda 2^*$: WEIGHTING PARAMETER

$$ide^*(n)=Cain\_hat(n)-Cain(n)$$
$$=\theta^*(n-1)^T\cdot\zeta^*(n)-Cain(n) \quad \cdots\cdots (55)$$

$$\theta^*(n)^T=[\alpha 1^*(n),\ \alpha 2^*(n),\ \beta 1^*(n),\ \beta 2^*(n),\cdots,\ \beta dy+1^*(n),\ \gamma 1^*(n)] \quad \cdots\cdots (56)$$

$$\zeta^*(n)^T=[Cain(n-dy),Cain(n-dy-1),Cain(n-dy-2),\cdots,Cain(n-2dy-1),1] \quad \cdots\cdots (57)$$

FIG. 32

$$Cain\_cmd\_f(n) = -POLE\_f^* \cdot Cain\_cmd\_f(n-1) + (1+POLE\_f^*) \cdot Cain\_cmd(n) \quad \cdots\cdots (58)$$

$$Ucain(n) = Ueq^*(n) + Urch^*(n) \quad \cdots\cdots (59)$$

$$\begin{aligned} Ueq^*(n) = \frac{1}{\beta 1^*(n)} \{ & -POLE^* \cdot Pre\_Cain(n) + Pre\_Cain(n-1) \\ & + POLE^* \cdot Pre\_Cain(n-2) - \alpha 1^*(n) \cdot Pre\_Cain(n-dy+1) \\ & - \alpha 2^*(n) \cdot Pre\_Cain(n-dy) - \beta 2^*(n) \cdot Ucain(n-1) \\ & - \cdots - \beta dy^*(n) \cdot Ucain(n-dy+1) \\ & - \beta dy+1^*(n) \cdot Ucain(n-dy) - \gamma 1^*(n) \\ & + Cain\_cmd\_f(n) + POLE^* \cdot Cain\_cmd\_f(n-1) \\ & - Cain\_cmd\_f(n-1) - POLE^* \cdot Cain\_cmd\_f(n-2) \} \end{aligned} \quad \cdots\cdots (60)$$

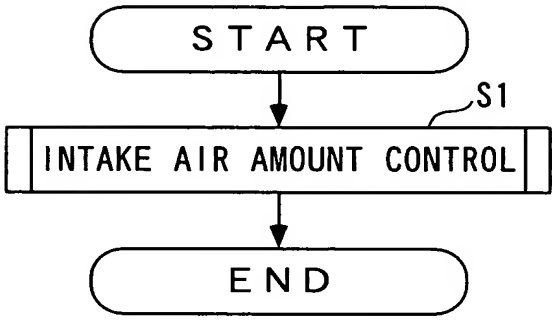
$$Urch^*(n) = -\frac{Krch^*}{\beta 1^*(n)} \cdot Pre\_\sigma^*(n) \quad \cdots\cdots (61)$$

$$Pre\_\sigma^*(n) = Pre\_E\_ca^*(n) + POLE^* \cdot Pre\_E\_ca^*(n-1) \quad \cdots\cdots (62)$$

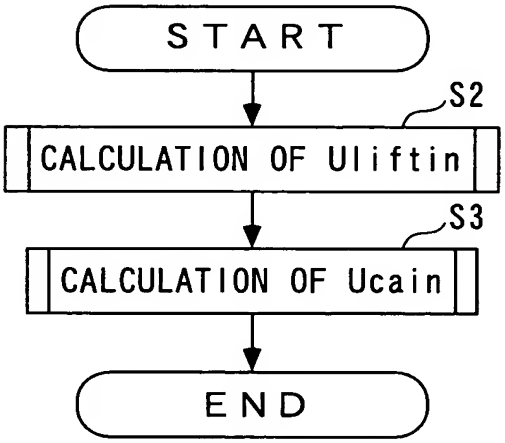
$$Pre\_E\_ca^*(n) = Pre\_Cain(n) - Cain\_cmd\_f(n) \quad \cdots\cdots (63)$$

FIG. 33

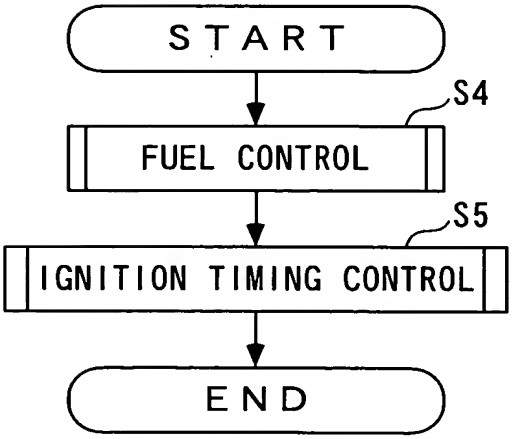
(a)


START
S1
INTAKE AIR AMOUNT CONTROL
END

(b)


START
S2
CALCULATION OF Uliftin
S3
CALCULATION OF Ucain
END

(c)


START
S4
FUEL CONTROL
S5
IGNITION TIMING CONTROL
END

Title: Intake Air Amount Control System for Internal Combustion Engine
Inventor: YASUI, et al.
Appln. No. : New Application
Docket No.: 108419-00082

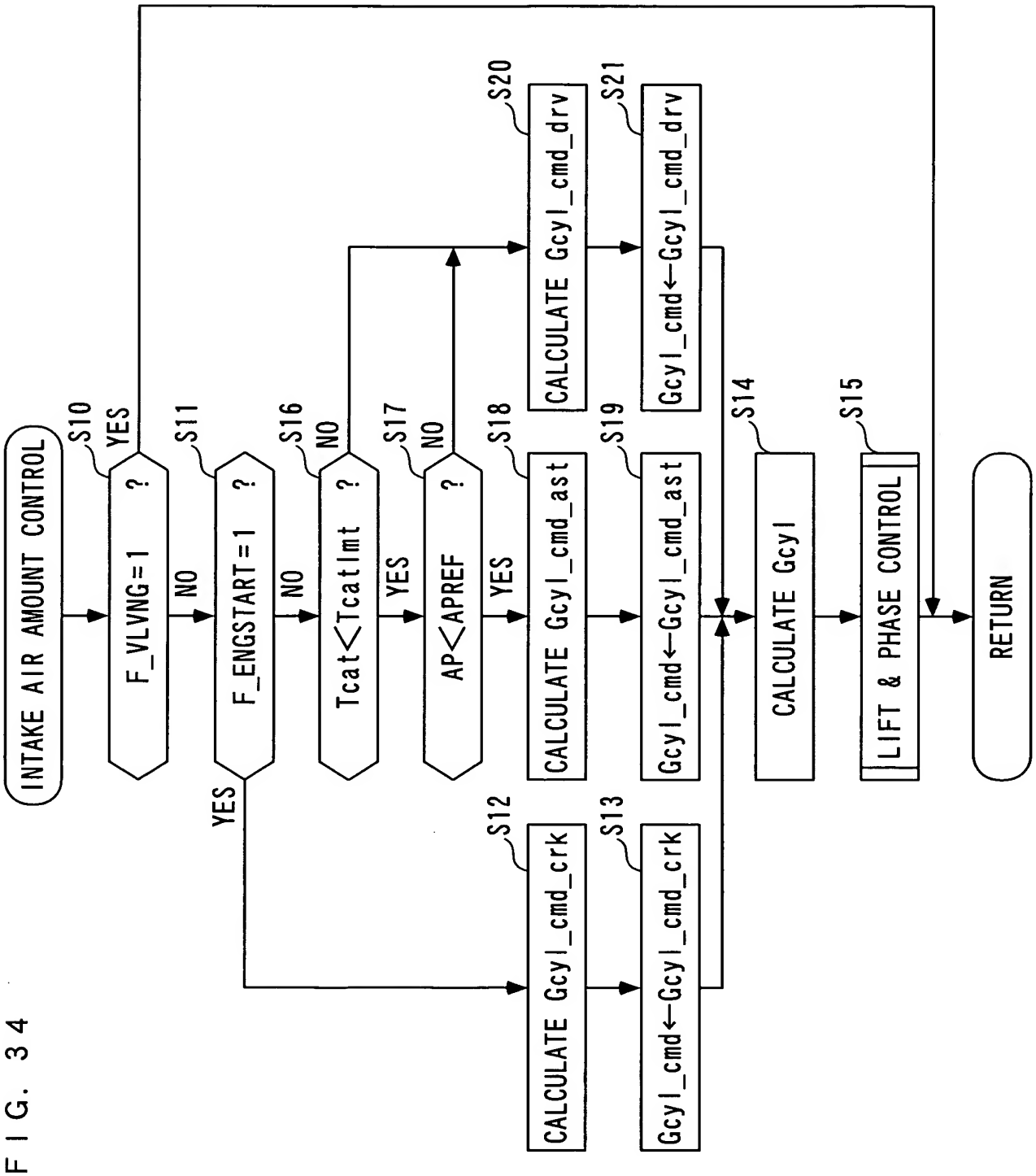


FIG. 34

Title: Intake Air Amount Control System for Internal Combustion Engine
Inventor: YASUI, et al.
Appln. No. : New Application
Docket No.: 108419-00082

FIG. 35

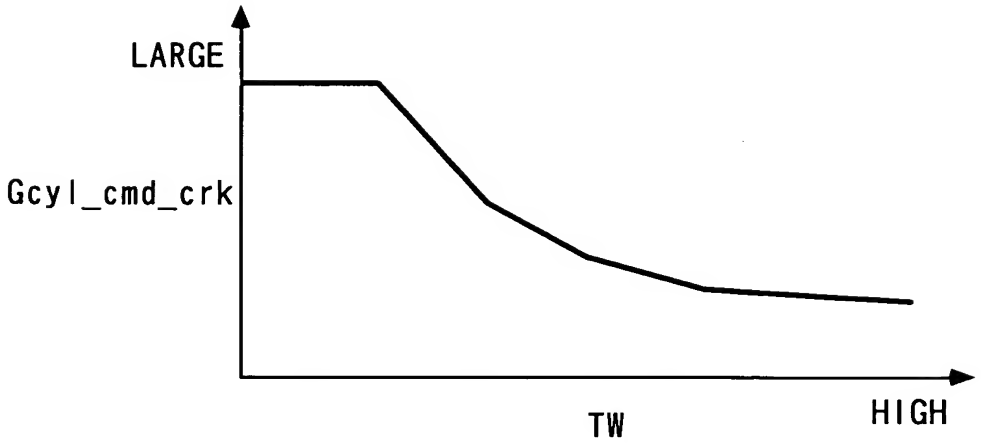


FIG. 36

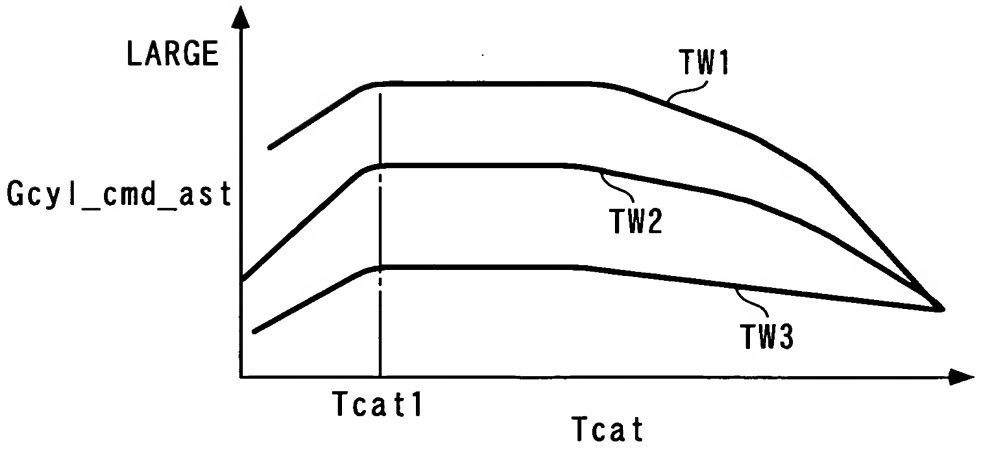


FIG. 37

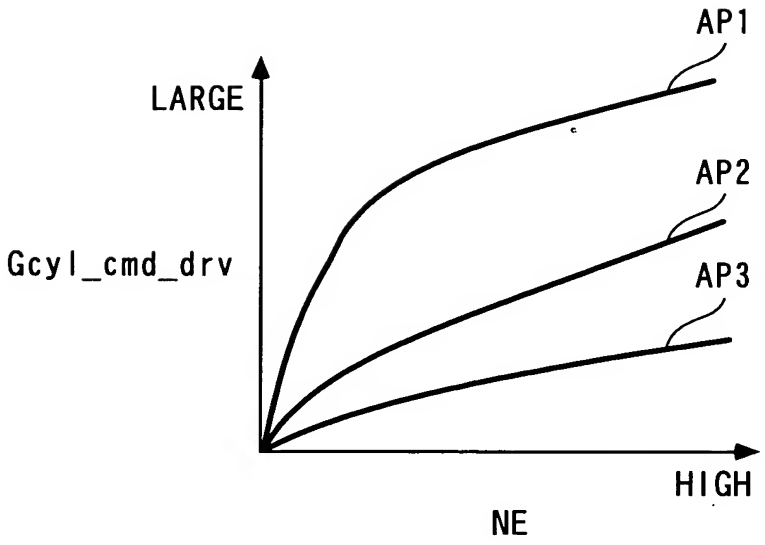


FIG. 38

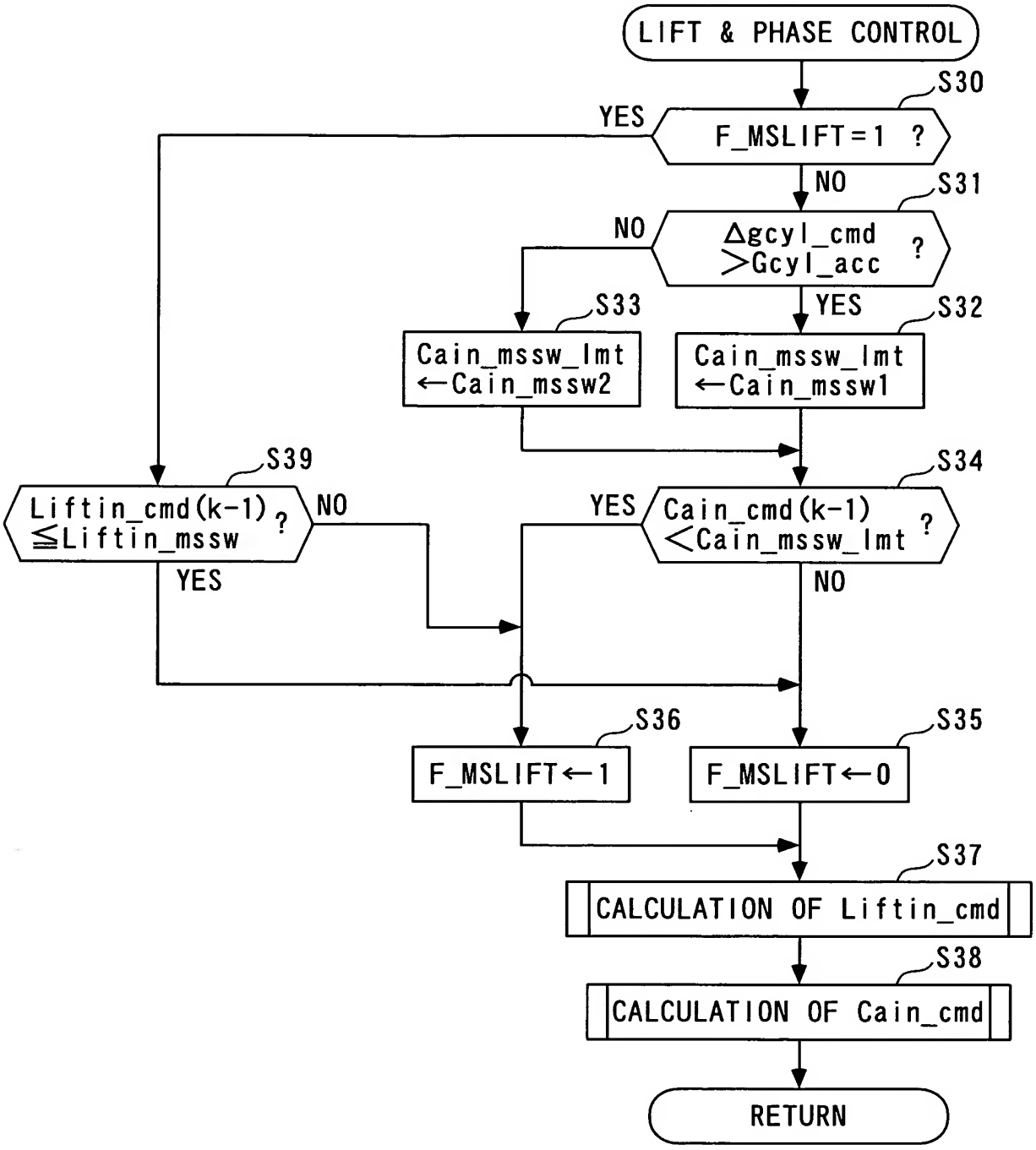

LIFT & PHASE CONTROL
S30
F_MSLIFT=1 ?
YES
NO
S31
Δgcyl_cmd >Gcyl_acc ?
NO
YES
S33
Cain_mssw_lmt ←Cain_mssw2
S32
Cain_mssw_lmt ←Cain_mssw1
S39
Liftin_cmd(k-1) ≦Liftin_mssw ?
NO
YES
S34
Cain_cmd(k-1) <Cain_mssw_lmt ?
YES
NO
S36
F_MSLIFT←1
S35
F_MSLIFT←0
S37
CALCULATION OF Liftin_cmd
S38
CALCULATION OF Cain_cmd
RETURN

FIG. 39

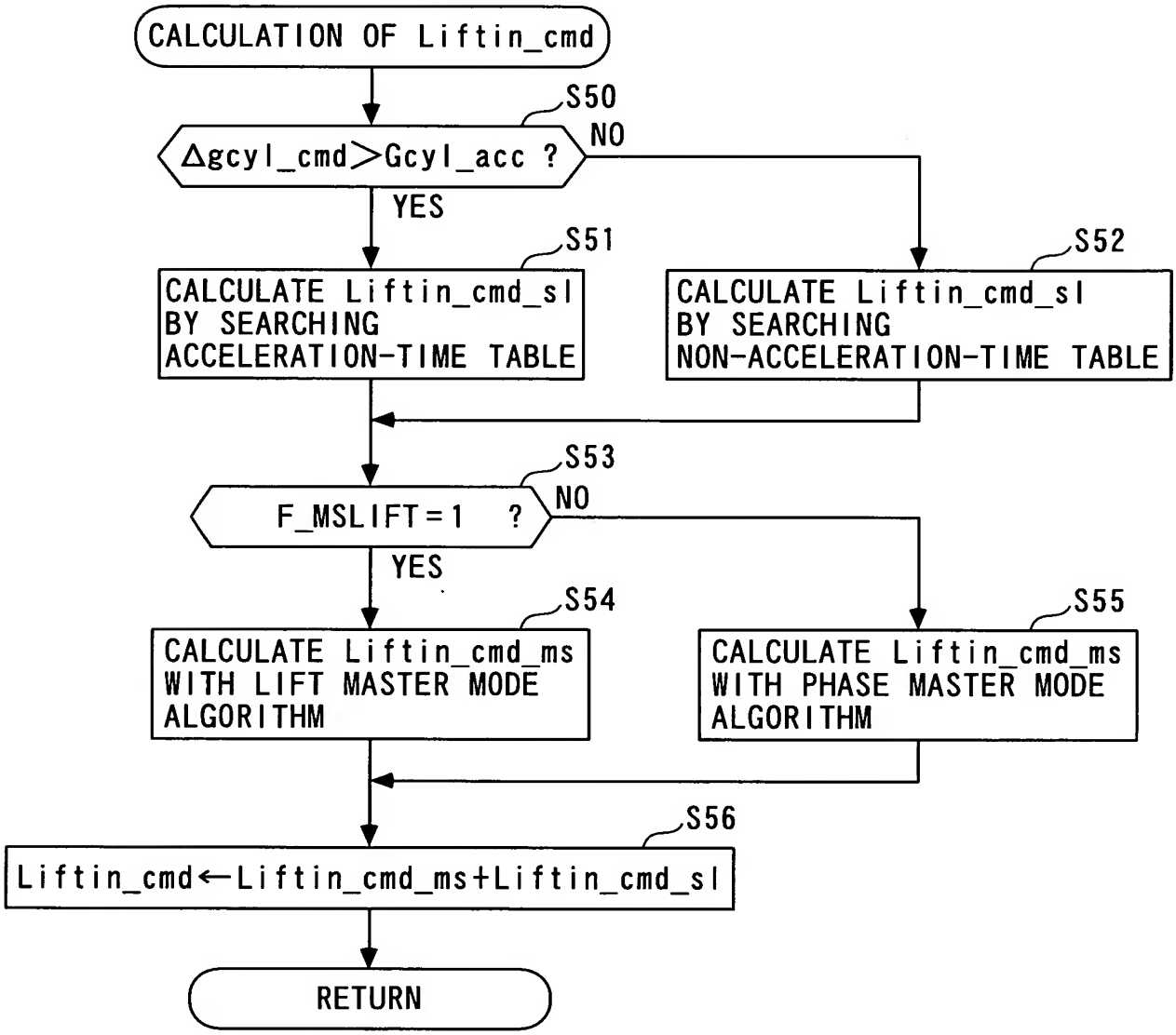

CALCULATION OF Liftin_cmd
S50
Δgcyl_cmd>Gcyl_acc ?
NO
YES
S51
CALCULATE Liftin_cmd_sl BY SEARCHING ACCELERATION-TIME TABLE
S52
CALCULATE Liftin_cmd_sl BY SEARCHING NON-ACCELERATION-TIME TABLE
S53
F_MSLIFT=1 ?
NO
YES
S54
CALCULATE Liftin_cmd_ms WITH LIFT MASTER MODE ALGORITHM
S55
CALCULATE Liftin_cmd_ms WITH PHASE MASTER MODE ALGORITHM
S56
Liftin_cmd←Liftin_cmd_ms+Liftin_cmd_sl
RETURN

FIG. 40

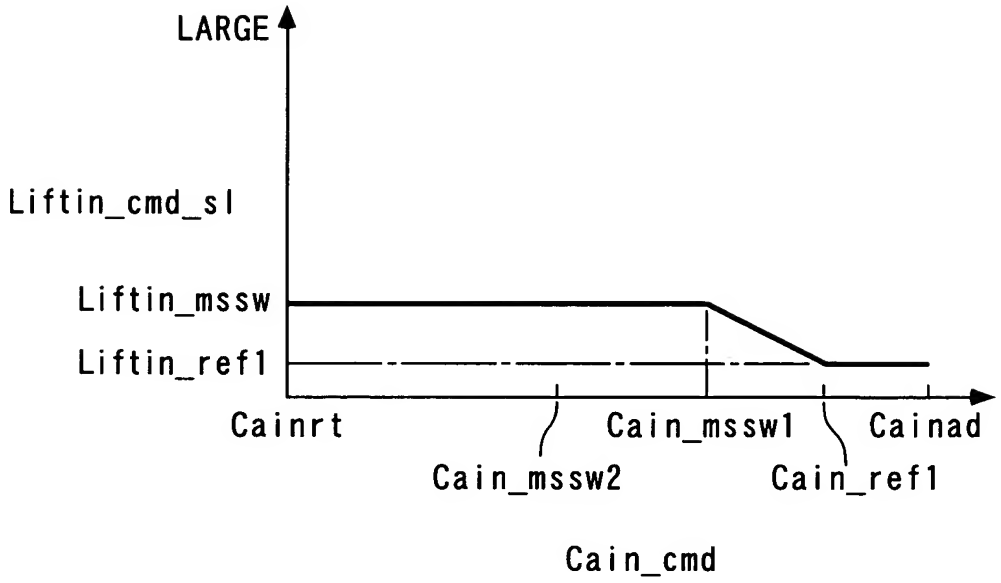

LARGE
Liftin_cmd_sl
Liftin_mssw
Liftin_ref1
Cainrt
Cain_mssw2
Cain_mssw1
Cain_ref1
Cainad
Cain_cmd

FIG. 41

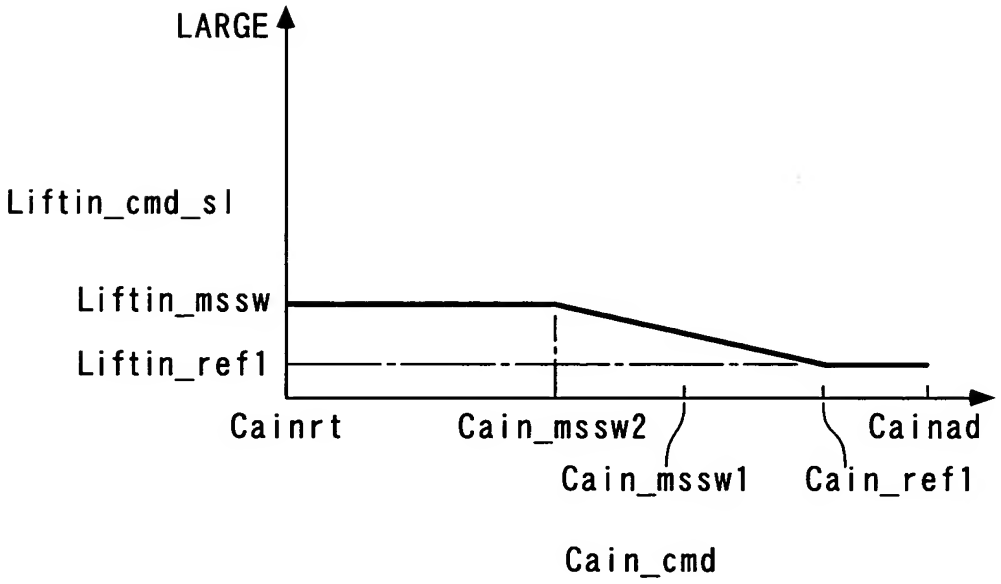

LARGE
Liftin_cmd_sl
Liftin_mssw
Liftin_ref1
Cainrt
Cain_mssw2
Cain_mssw1
Cain_ref1
Cainad
Cain_cmd

FIG. 42

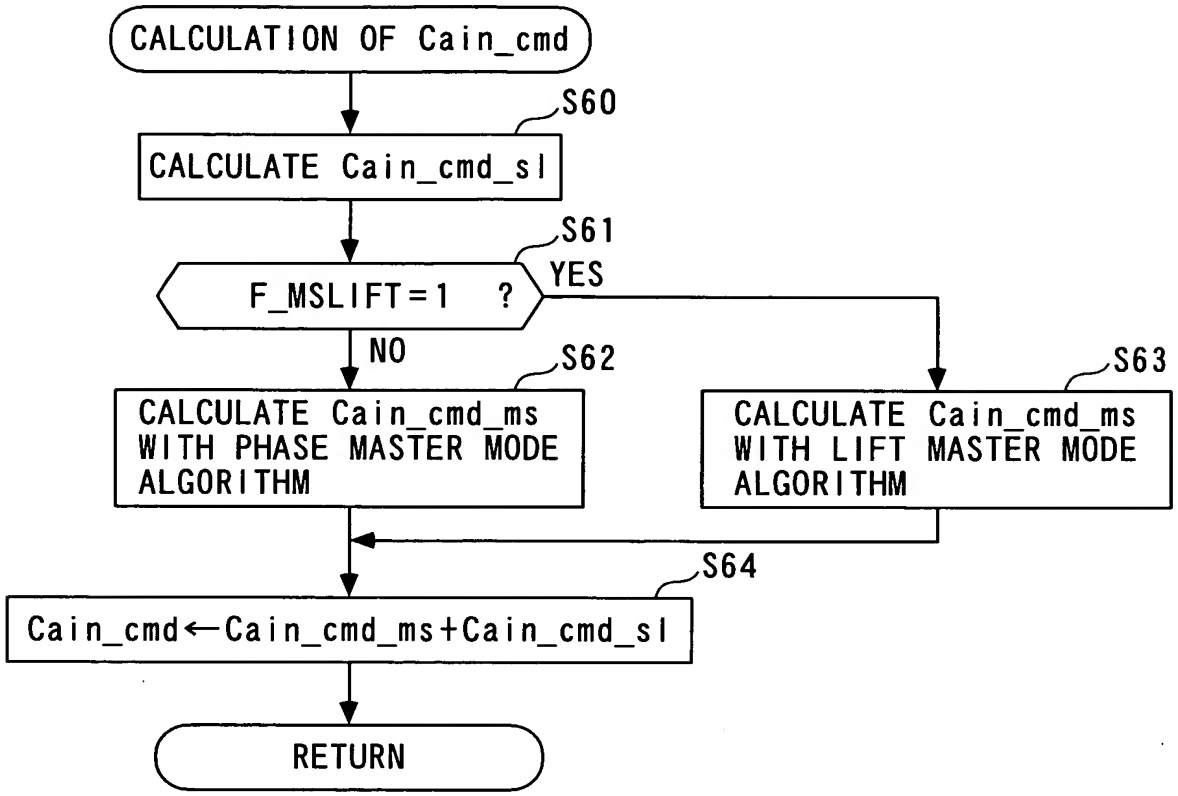

CALCULATION OF Cain_cmd
S60
CALCULATE Cain_cmd_sl
S61
F_MSLIFT=1 ?
YES
NO
S62
CALCULATE Cain_cmd_ms WITH PHASE MASTER MODE ALGORITHM
S63
CALCULATE Cain_cmd_ms WITH LIFT MASTER MODE ALGORITHM
S64
Cain_cmd←Cain_cmd_ms+Cain_cmd_sl
RETURN

FIG. 43

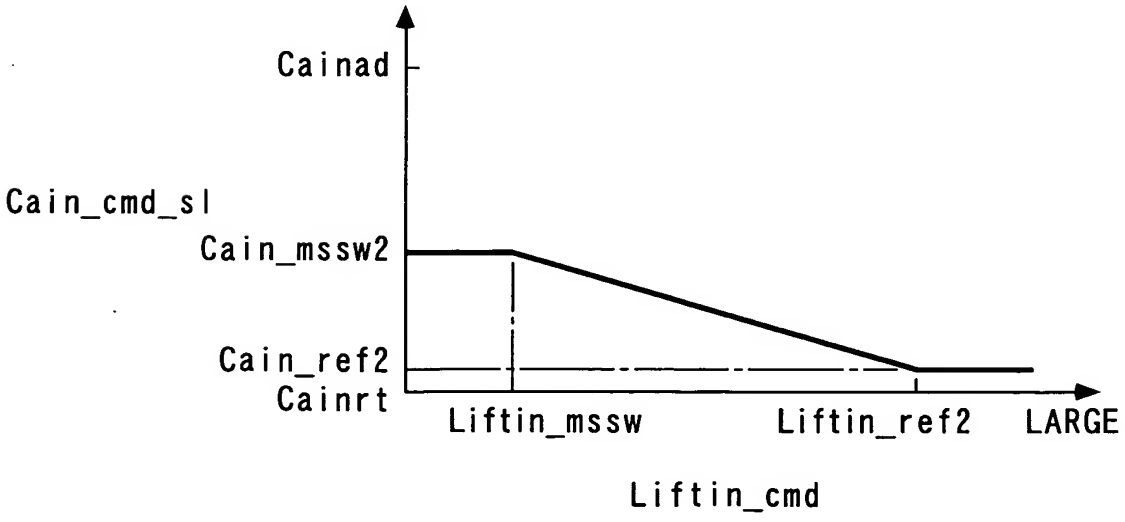

Cainad
Cain_cmd_sl
Cain_mssw2
Cain_ref2
Cainrt
Liftin_mssw
Liftin_ref2
LARGE
Liftin_cmd

FIG. 44

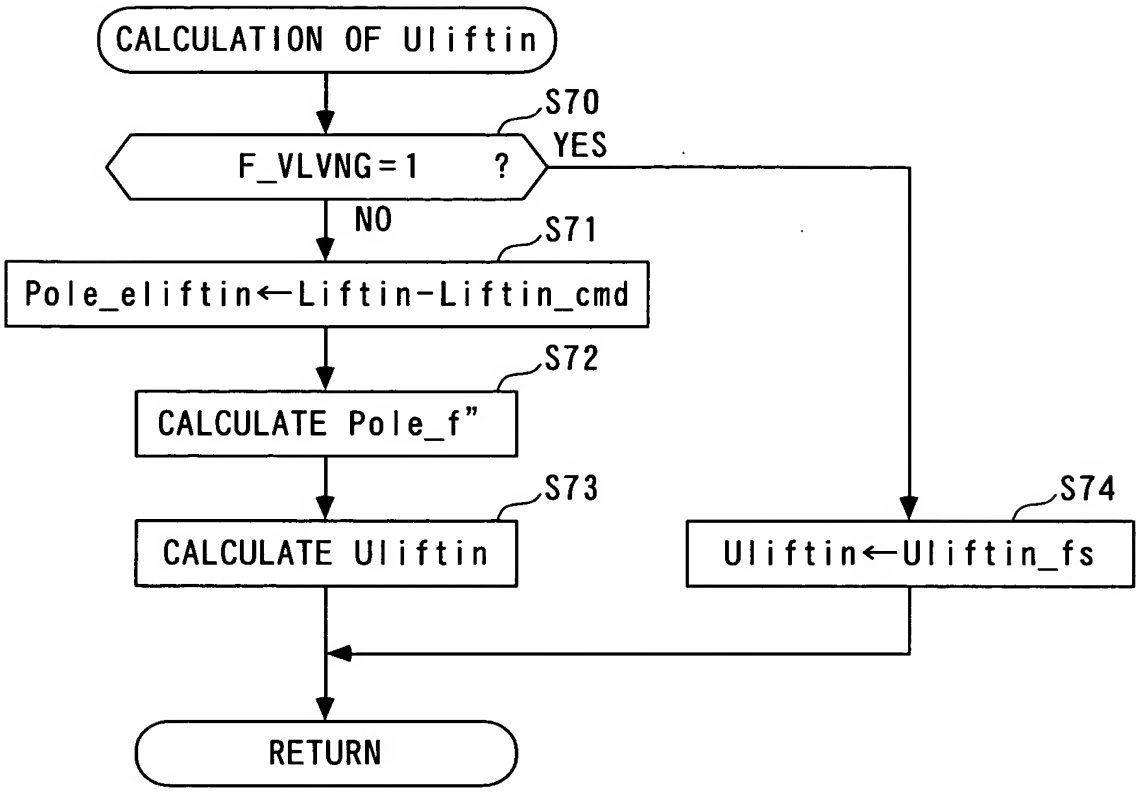

CALCULATION OF Uliftin
S70
F_VLVNG=1 ?
YES
NO
S71
Pole_eliftin←Liftin-Liftin_cmd
S72
CALCULATE Pole_f"
S73
CALCULATE Uliftin
S74
Uliftin←Uliftin_fs
RETURN

FIG. 45

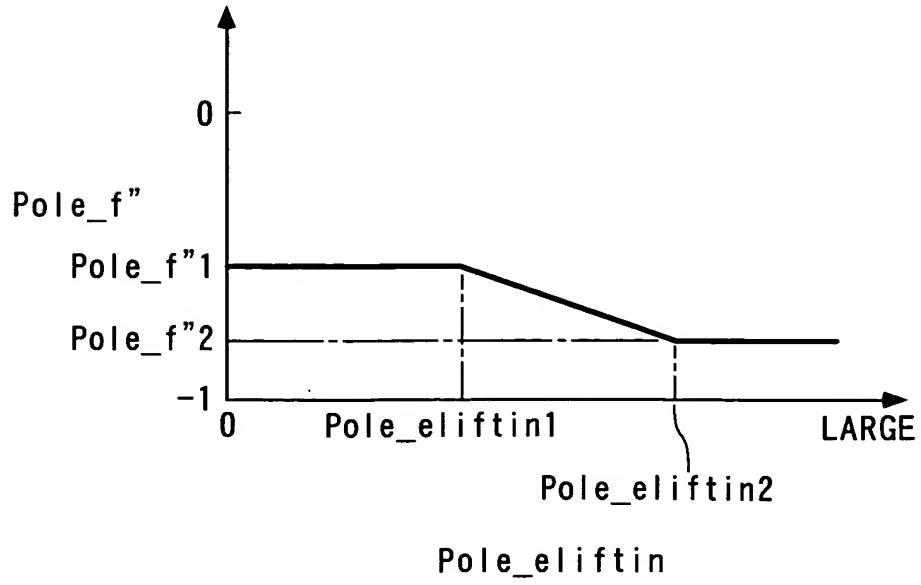

0
Pole_f"
Pole_f"1
Pole_f"2
-1
0
Pole_eliftin1
LARGE
Pole_eliftin2
Pole_eliftin

FIG. 46

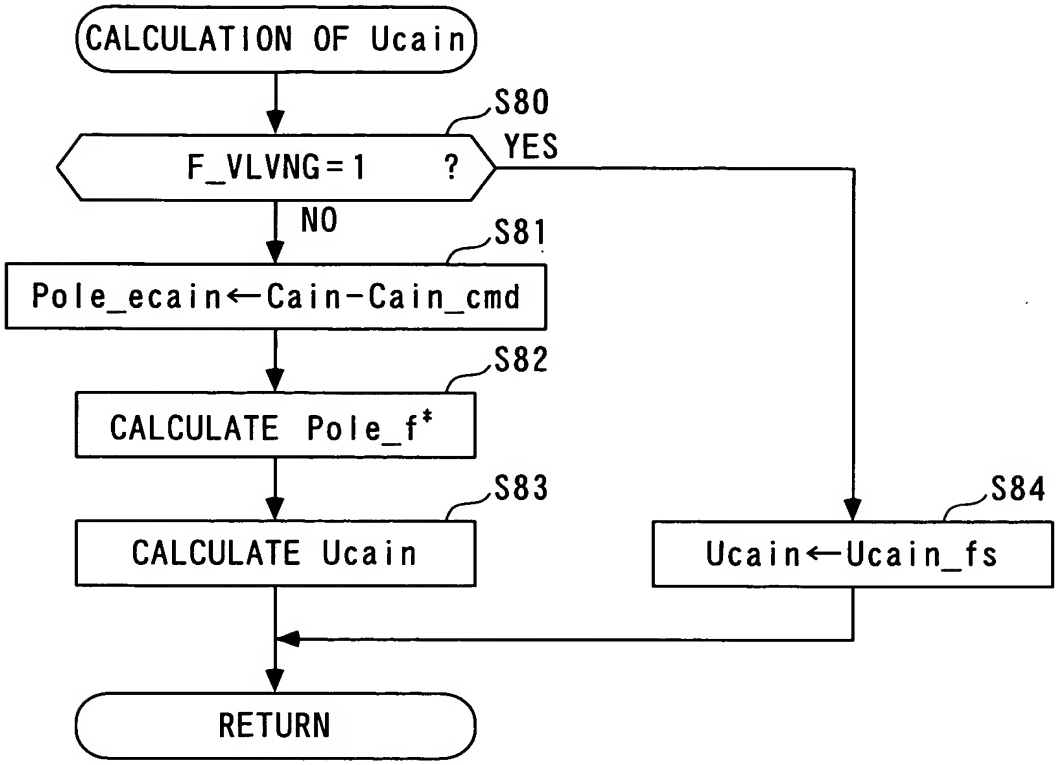

CALCULATION OF Ucain
S80
F_VLVNG=1 ?
YES
NO
S81
Pole_ecain←Cain-Cain_cmd
S82
CALCULATE Pole_f*
S83
CALCULATE Ucain
S84
Ucain←Ucain_fs
RETURN

FIG. 47

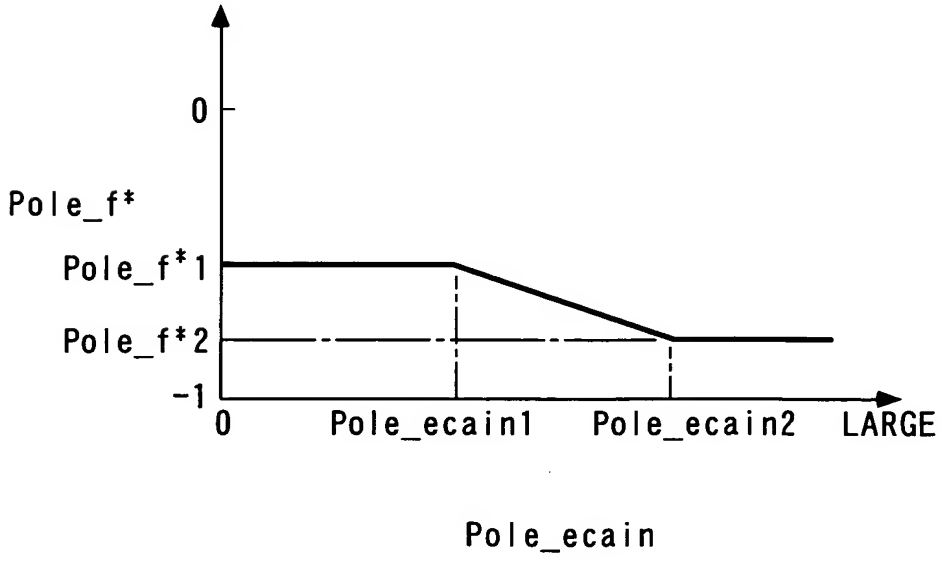

0
Pole_f*
Pole_f*1
Pole_f*2
-1
0
Pole_ecain1
Pole_ecain2
LARGE
Pole_ecain

FIG. 48

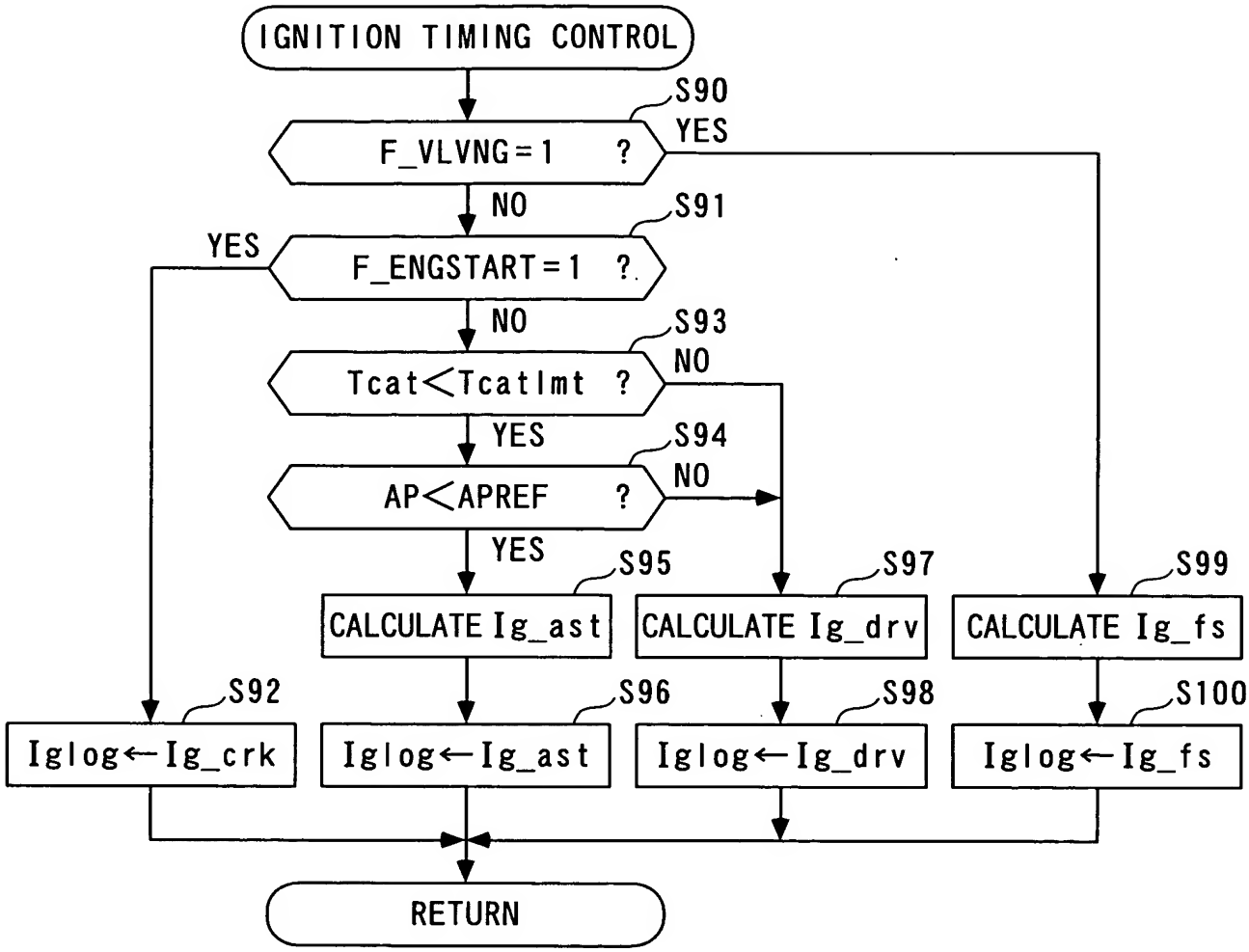

IGNITION TIMING CONTROL
S90
F_VLVNG=1 ?
YES
NO
S91
YES
F_ENGSTART=1 ?
NO
S93
Tcat<TcatImt ?
NO
YES
S94
AP<APREF ?
NO
YES
S95
S97
S99
CALCULATE Ig_ast
CALCULATE Ig_drv
CALCULATE Ig_fs
S92
S96
S98
S100
Iglog←Ig_crk
Iglog←Ig_ast
Iglog←Ig_drv
Iglog←Ig_fs
RETURN

FIG. 49

$$Ig\_ast = Ig\_ast\_base - Krch^{\#} \cdot \sigma^{\#}(m) - Kadp^{\#} \sum_{i=0}^{m} \cdot \sigma^{\#}(i) \quad \cdots\cdots (64)$$

$$\sigma^{\#}(m) = Enast(m) + POLE^{\#} \cdot Enast(m-1) \quad \cdots\cdots (65)$$

$$Enast(m) = NE(m) - NE\_ast \quad \cdots\cdots (66)$$

$$Ig\_fs = Ig\_fs\_base - Krch^{\#\#} \cdot \sigma^{\#\#}(m) - Kadp^{\#\#} \sum_{i=0}^{m} \cdot \sigma^{\#\#}(i) \quad \cdots\cdots (67)$$

$$\sigma^{\#\#}(m) = Enfs(m) + POLE^{\#\#} \cdot Enfs(m-1) \quad \cdots\cdots (68)$$

$$Enfs(m) = NE(m) - NE\_fs \quad \cdots\cdots (69)$$

FIG. 50

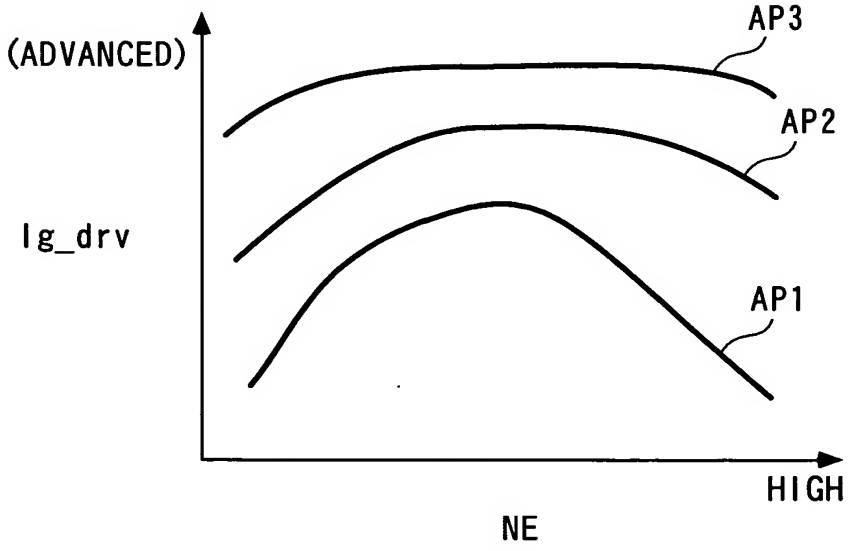


FIG. 51

$$Gcyl\_cmd\_f(k) = -POLE\_f \cdot Gcyl\_cmd\_f(k-1) + (1+POLE\_f) \cdot Gcyl\_cmd(k) \quad \cdots\cdots (70)$$

$$Liftin\_cmd\_ms(k) = Urch(k) + Uadp(k) \quad \cdots\cdots (71)$$

$$Urch(k) = -\frac{Krch}{b1} \cdot \sigma(k) \quad \cdots\cdots (72)$$

$$Uadp(k) = -\frac{Kadp}{b1} \cdot \omega(k) \quad \cdots\cdots (73)$$

$$\omega(k) = \omega(k-1) + \sigma(k) \quad \cdots\cdots (74)$$

$$\omega(k) = -\frac{Krch}{Kadp} \cdot \sigma(k) \quad \cdots\cdots (75)$$

$$\sigma(k) = Egc(k) + POLE \cdot Egc(k-1) \quad \cdots\cdots (76)$$

$$Egc(k) = Gcyl(k) - Gcyl\_cmd\_f(k) \quad \cdots\cdots (77)$$

FIG. 52

$$Gcyl\_cmd\_f(k) = -POLE\_f \cdot Gcyl\_cmd\_f(k-1) + (1+POLE\_f) \cdot Gcyl\_cmd(k) \quad \cdots\cdots (78)$$

$$Cain\_cmd\_ms(k) = Urch'(k) + Uadp'(k) \quad \cdots\cdots (79)$$

$$Urch'(k) = -\frac{Krch'}{b1} \cdot \sigma'(k) \quad \cdots\cdots (80)$$

$$Uadp'(k) = -\frac{Kadp'}{b1} \cdot \omega'(k) \quad \cdots\cdots (81)$$

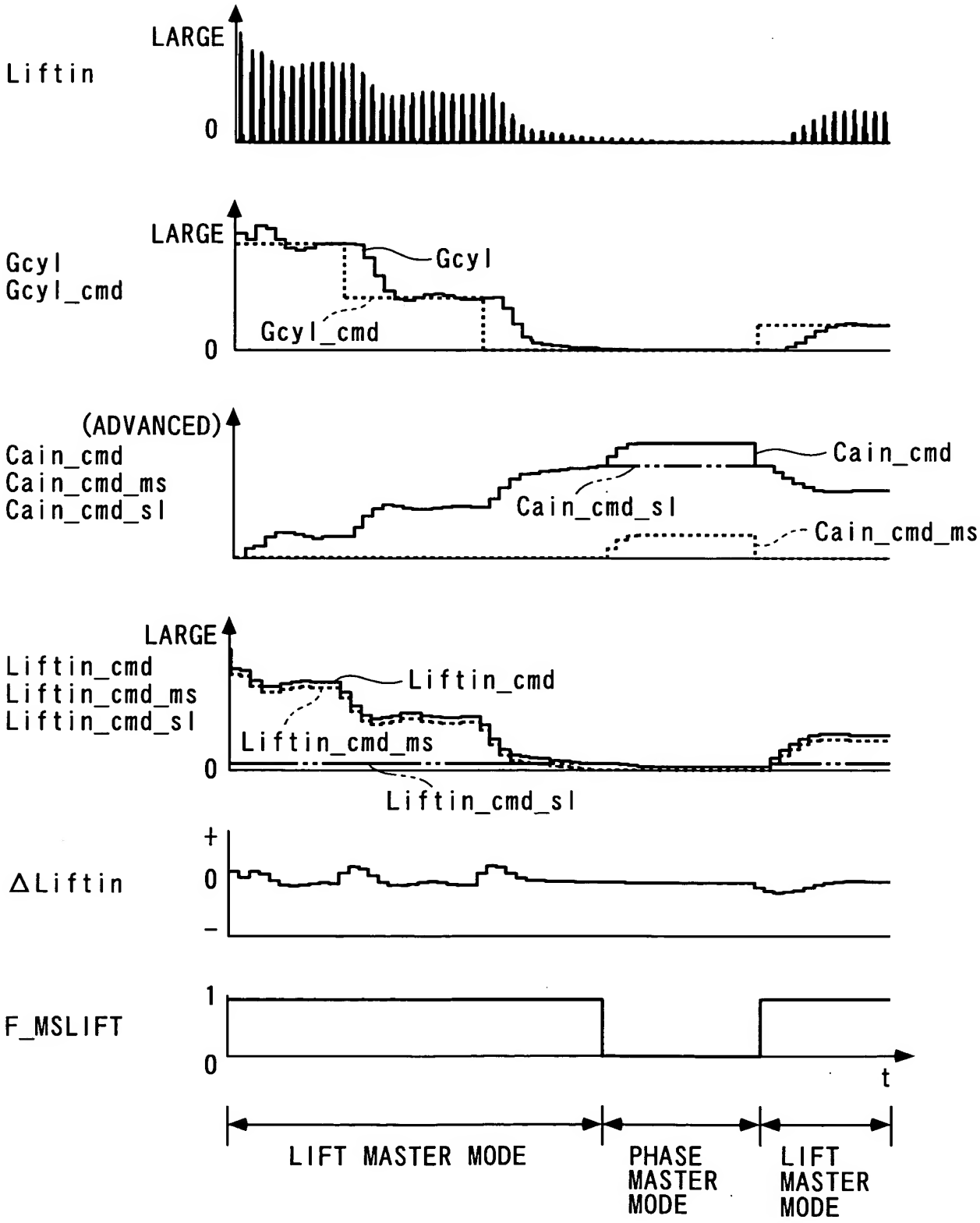
$$\omega'(k) = \omega'(k-1) + \sigma'(k) \quad \cdots\cdots (82)$$

$$\omega'(k) = -\frac{Krch'}{Kadp'} \cdot \sigma'(k) \quad \cdots\cdots (83)$$

$$\sigma'(k) = Egc(k) + POLE' \cdot Egc(k-1) \quad \cdots\cdots (84)$$

$$Egc(k) = Gcyl(k) - Gcyl\_cmd\_f(k) \quad \cdots\cdots (85)$$

FIG. 53


LARGE
Liftin
0
LARGE
Gcyl
Gcyl_cmd
Gcyl
Gcyl_cmd
0
(ADVANCED)
Cain_cmd
Cain_cmd_ms
Cain_cmd_sl
Cain_cmd
Cain_cmd_sl
Cain_cmd_ms
LARGE
Liftin_cmd
Liftin_cmd_ms
Liftin_cmd_sl
Liftin_cmd
Liftin_cmd_ms
0
Liftin_cmd_sl
+
ΔLiftin
0
−
1
F_MSLIFT
0
t
LIFT MASTER MODE
PHASE MASTER MODE
LIFT MASTER MODE